Technical Support Document (TSD)

for the Final Transport Rule

Docket ID No. EPA-HQ-OAR-2009-0491

Significant Contribution and State Emissions Budgets

Final Rule TSD

U.S. Environmental Protection Agency

Office of Air and Radiation

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This Technical Support Document (TSD) provides information that supports EPA's analysis to quantify upwind state emissions that significantly contribute to nonattainment or interfere with maintenance of the National Ambient Air Quality Standards (NAAQS) in downwind states in the final Transport Rule. The analysis is described in detail in section VI in the preamble to the final rule. This TSD is organized as follows:

A. Background on EPA's Analysis to Quantify Emissions that Significantly Contribute to Nonattainment or Interfere with Maintenance

Sections V and VI of the final Transport Rule (TR) preamble describe EPA's approach to identify upwind states' emissions that significantly contribute to nonattainment or interfere with maintenance downwind with respect to the 1997 and 2006 $PM_{2.5}$ NAAQS and the 1997 ozone NAAQS. As described in the preamble, the approach uses air quality analysis to identify monitoring sites with projected nonattainment and maintenance problems for the $PM_{2.5}$ and ozone NAAQS as well as upwind states whose contributions to these monitoring sites meet or exceed specified threshold amounts. See sections V.C and V.D in the TR preamble and the Air Quality Modeling Final Rule TSD for a detailed discussion of these air quality analyses.

As described in TR preamble section VI, after identifying upwind-to-downwind linkages based on air quality contribution thresholds, EPA uses a multi-step process to quantify each state's significant contribution to nonattainment and interference with maintenance. The first step in the process identifies the emissions projected to remain in each state at ascending cost thresholds of emissions reductions. See section B in this TSD for discussion of this analysis. Next, the process uses an air quality assessment tool (AQAT) to estimate the impact of the upwind state reductions on downwind state air quality at different cost-per-ton levels. See section C in this TSD for discussion of the development and use of the air quality assessment tool.

TR preamble section VI.D reviews the cost and air quality impact analyses referenced in preamble sections VI.B and VI.C and explains EPA's determination of the resulting specific cost thresholds that are used to quantify each state's significant contribution to nonattainment and interference with maintenance. Cost thresholds were applied specifically to the upwind states identified for each program as listed in the table below.

Table A-1. Geography to Which Cost Thresholds Were Applied

SO2 Group 1	SO2 Group 2	Annual NOx	Ozone Season NOx
Illinois	Alabama	Illinois	Alabama
Indiana	Georgia	Indiana	Arkansas
Iowa	Kansas	Iowa	Florida
Kentucky	Minnesota	Kentucky	Georgia
Maryland	Nebraska	Maryland	Illinois
Michigan	South Carolina	Michigan	Indiana
Missouri	Texas	Missouri	Iowa*
New Jersey		New Jersey	Kansas*
New York		New York	Kentucky
North Carolina		North Carolina	Louisiana
Ohio		Ohio	Maryland
Pennsylvania		Pennsylvania	Michigan*
Tennessee		Tennessee	Mississippi
Virginia		Virginia	Missouri*
West Virginia		West Virginia	New Jersey
Wisconsin		Wisconsin	New York
		Alabama	North Carolina
		Georgia	Ohio
		Kansas	Oklahoma*
		Minnesota	Pennsylvania
		Nebraska	South Carolina
		South Carolina	Tennessee
		Texas	Texas
			Virginia
			West Virginia
			Wisconsin*

*Indicates a state (IA, KS, MI, OK, WI, and MO) that is included in the supplemental notice of proposed rulemaking for ozone-season NO_x emission reductions. See the preamble for details.

A set of Excel spreadsheet files containing AQAT data supporting the final Transport Rule's determination of emissions that constitute significant contribution to nonattainment and interference with maintenance is available in the docket for this rulemaking (Docket ID No. EPA–HQ–OAR–2009–0491). Appendix C in this TSD describes these files.

B. Electric Generating Unit Significant Contribution Cost Analysis

EPA used its updated version 4.10_FTransport of the Integrated Planning Model (IPM) to analyze the annual SO_2, annual NO_x, and ozone-season NO_x emissions reductions available from electric generating units (EGUs) at various cost levels in each upwind state. IPM is a multiregional, dynamic, deterministic linear programming model of the U.S. electric power sector that EPA uses to analyze cost and emissions impacts of environmental policies. See "Documentation for EPA Base Case v.4.10 Using the Integrated Planning Model" and "Documentation Supplement for EPA Base Case v.4.10_FTransport – Updates for Final Transport Rule" for further description of the IPM model.

EPA first modeled a base case EGU emissions scenario (i.e., a scenario absent any emission reduction requirements related to the Transport Rule). The base case modeling includes the Title IV SO_2 cap and trade program; NO_x SIP Call regional ozone season cap and trade program; settlements; and state and federal rules as listed in the IPM documentation referenced above. As explained in section V.B of the preamble, the base case does not include the Clean Air Interstate Rule (CAIR), which will be replaced by this rule.

Using IPM, EPA then modeled the emissions that would occur within each state at ascending cost thresholds of emissions control. EPA designed a series of IPM runs that imposed increasing cost thresholds for SO_2, annual NO_x, and ozone-season NO_x emissions and tabulated those projected emissions for each state at each cost level. EPA refers to these tabulations as "cost curves" in TR preamble section VI.B.[1] The cost curves report the remaining emissions at each cost threshold after the state has made emission reductions that are available up to the particular cost threshold analyzed.

This part of the analysis applied cost thresholds to all fossil-fuel-fired EGUs with a capacity greater than 25 MW in each state covered under the relevant Transport Rule control program. At all cost thresholds analyzed, emissions projected for covered states reflect the year-round operation of all existing SO_2 and NO_x pollution controls in states covered by the Transport Rule for $PM_{2.5}$ and the ozone-season operation of all existing NO_x pollution controls in states covered by the Transport Rule only for ozone. Because

[1] These projected state level emissions for each "cost threshold" run are presented in a several formats. The IPM analysis outputs available in the docket contain a "state emissions" file for each analysis. The file contains three worksheets, the first is titled "all units" which shows aggregate emissions for all units in the state. The second is titled "all fossil > 25MW" and shows emissions for a subset of these units that have a capacity greater than 25 MW. The emissions in the "all fossil > 25 MW" worksheet are used to derive the budgets for each state at the cost thresholds determined to eliminate significant contribution to nonattainment or interference with maintenance in that upwind state, in an average year. The "fossil & biomass" worksheet reports total emissions from fossil-fired and biomass-fired units, and represents the state level emission total used in the AQAT analysis. These "fossil & biomass" emission totals are used as inputs for CAMx air quality modeling, which is why those emissions were used as inputs for AQAT. In the Transport Rule proposal Technical Support Document "Analysis to Quantify Significant Contribution", EPA stated that the "all units" emissions used in the AQAT analysis for the proposal and the emissions used in the CAMx air quality modeling were slightly different. EPA committed to determining the origin of the slight difference and removing it for the final Transport Rule. In this final rule modeling, the emissions reported in the "Fossil & Biomass" worksheets were used as emission inputs in both AQAT and CAMx modeling of the scenarios that were analyzed with both models.

of the time required to build advanced pollution controls, the model was prevented from building any new post-combustion controls such as selective catalytic reduction (SCR) or flue-gas desulfurization (FGD) in 2012 in response to the cost thresholds.[2] The modeling does allow the addition or upgrading of NO_x combustion controls in 2012 (such as Low NOx Burners (LNB)).

EPA first conducted this cost curve analysis for ozone-season NO_x. EPA imposed cost thresholds ranging from $500 per ton to $5,000 per ton of ozone-season NO_x. These cost thresholds were applied to the states covered by the final Transport Rule for ozone control as well as to the states for which EPA is issuing a supplemental proposal to require ozone-season reductions, as discussed in section III of the Transport Rule preamble. The IPM-projected EGU emissions of ozone-season NO_x from the "Fossil > 25 MW" units are shown at each cost threshold for 2012 and 2014 in Table B-1.[3]

EPA then conducted cost curve analysis for annual NO_x, imposing cost thresholds ranging from $500 to $2,500 per ton in states covered in the final Transport Rule for $PM_{2.5}$ NAAQS. The IPM-projected EGU emissions of annual NO_x from the "Fossil > 25 MW" units are shown at each cost threshold for 2012 and 2014 in Table B-2.

As explained in TR preamble section VI.D, EPA determined that $500/ton was the appropriate cost threshold for ozone-season NO_x control at all covered states in this rulemaking. EPA also determined that $500/ton was the appropriate cost threshold for annual NO_x control at all covered states in concert with varying degrees of SO_2 control to eliminate significant contribution to nonattainment and interference with maintenance of the $PM_{2.5}$ NAAQS. In line with these determinations, EPA conducted cost curve analysis for SO_2 while simultaneously imposing cost thresholds of $500/ton for ozone-season NO_x in Transport Rule ozone states and $500/ton for annual NO_x in Transport Rule $PM_{2.5}$ states. While holding these ozone-season NO_x and annual NO_x cost thresholds constant, EPA examined different SO_2 cost thresholds.

For SO_2 emissions, the lowest cost threshold that EPA examined was $500 per ton starting in 2012 and for each year thereafter. EPA then used the Air Quality Assessment Tool (AQAT) to identify improvements in downwind air quality at $500 per ton. EPA determined that for 7 states, emission reductions at this $500 per ton threshold successfully eliminated significant contribution to nonattainment and interference with maintenance at downwind receptors, as those receptors no longer had projected nonattainment and/or maintenance problems when emissions were limited by a $500/ton cost level. These 7 states - Alabama, Georgia, Kansas, Nebraska, Minnesota, South Carolina, and Texas – are referred to as Group 2 states. Because their significant

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[2] IPM results do include newly built 2012 post-combustion pollution control retrofits in base case modeling, cost curve runs, and remedy runs. These 2012 retrofits do not reflect any controls installed in response to the Transport Rule, but instead represent those that are already announced and/or under construction and expected to be online by 2012, or controls that were projected to be built in the base case in response to existing consent decree or state rule requirements.

[3] EPA notes that while ozone-season emissions generally decline as the cost threshold increases, there are instances where a state may see a small increase in emissions at a higher cost threshold compared to a lower cost threshold analyzed. This is related to the interconnected, interstate nature of the grid, and the ability of generation to shift from a less efficienct/higher emitting source in one state to a more efficient/lower emitting source in another state at higher cost levels. In other words, as multiple states experience the higher cost threshold on ozone-season NO_X, a region may minimize cost by dispatching more generation from lower-emitting-rate units in a particular state that counterintuitively raise that state's total ozone-season NO_X emissions, even as the regional ozone-season NO_X emissions decline as a result.

contribution to nonattainment and interference with maintenance was eliminated at this \$500/ton threshold, all subsequent cost curve analysis applied a constant \$500/ton threshold on these states' SO_2 emissions.

EPA did not examine other cost thresholds in any states for 2012, as \$500 per ton is a reasonably representative cost threshold to incentivize operation of existing control equipment, and higher cost thresholds may induce new advanced control retrofits that require a longer lead time for installation. EPA, however, did examine higher cost thresholds for SO_2 in 2014 for Group 1 states. EPA examined cost levels of \$1,600/ton, \$2,300/ton, \$2,800/ton, and \$3,300/ton as a representative sampling of points along the SO_2 cost curve explored at proposal. To assess the upper bounds of the cost curve, EPA examined a very stringent scenario by restricting each Group 1 state's 2014 SO_2 emissions to approximately 30% of that state's emissions modeled at the \$3,300/ton level in 2014. When this type of quantity constraint was imposed, the marginal cost projected by the model to reach such emission levels was approximately \$10,000/ton, and therefore EPA refers to this scenario as the "\$10,000/ton" cost threshold scenario for the remainder of this document and throughout the final Transport Rule materials. <u>See</u> Table Appendix A-1 in Appendix A for a list of IPM analyses..

In the cost curves with ascending SO_2 cost thresholds, cost thresholds for each pollutant (SO_2, ozone-season NO_x, and annual NO_x) were analyzed simultaneously. This methodology for the final rule's analysis represents a technical improvement on the analysis used in the proposal, where cost thresholds for each pollutant were examined independently with no emission control cost assumed for the other two pollutants (see Appendix Table A-1). The final rule's cost curves reflect a price signal for all pollutants for which that state is covered. This finalized approach better captures the real-world interactions between simultaneous SO_2, annual NO_x, and ozone season NO_x policy requirements across the states covered by the Transport Rule. Cost-effective actions taken to reduce annual NO_x, for example, may influence the cost of reducing SO_2. The modeling of these final cost curves captures these important economic interactions.

At each cost threshold examined with the IPM model, the model outputs include state emission totals from "All Fossil and Biomass" as well as from "All fossil > 25 MW" are reported. The "All Fossil and Biomass" totals are meant to reflect total state EGU emissions used for subsequent air quality modeling. The "All Fossil > 25 MW" totals represent an approximation of emissions from EGUs subject to the Transport Rule. These two state level totals are very close in value. The later is generally slightly lower as it is a subset of the former. Table B-6 shows the state-level SO_2 emissions from fossil and biomass units as the Group 1 2014 cost threshold is varied in these final cost curve runs. Note that although the Group 1 cost threshold is the only cost threshold that changes, emission levels in some Group 2 states may change as a consequence of generation shifting between states in response to the increasing Group 1 cost threshold. Changes in Group 2 state-level emissions in this analysis reveal the interconnected nature of the power sector and the fact that generation and fuel consumption patterns are not independently determined inside each state. As a result, emission levels from EGUs may vary in a given state based on decisions taken by EGUs in other states connected to the same grid.

These resulting state SO_2 emissions levels from "All Fossil and Biomass" at each of these cost thresholds analyzed were examined in AQAT to determine the impact on downwind air quality. Section VI.D of the TR preamble explains how EPA considered the results of the cost and air quality analyses described in this TSD to determine the appropriate set of cost thresholds for eliminating significant contribution to nonattainment and interference with maintenance. EPA used the emissions from all fossil and biomass EGUs in its air quality modeling to capture the impact of all upwind EGU emissions on downwind receptors as explained in section C of this document. EPA used the remaining state level emissions from the "All Fossil > 25 MW" at the final cost threshold levels to determine state budgets, as this set of units generally reflect those EGUs covered by the Transport Rule. Transport Rule applicability is explained in section VII.B of the preamble. The state level emissions for ozone-season NO_x, annual NOx, and SO_2 emissions from fossil units greater than 25 MW are shown in Tables B-3 through B-5 below and provided in TR Docket. These tables show how state level emissions for each of these pollutants change as the cost threshold is varied for Group 1 SO_2 states in the "final cost curves."

As explained in preamble section VI.D, EPA identified $2,300/ton as the appropriate cost threshold in Group 1 states for addressing significant contribution to nonattainment and interference with maintenance. EPA notes that the modeling of the $2,300/ton cost threshold for Group 1 states includes simultaneously application of all of the selected cost thresholds for defining significant contribution to nonattainment and interference with maintenance under the Transport Rule. For example, it imposes a $500/ton cost threshold for SO_2, NO_X, and ozone-season NO_X in TR states covered for those emissions in 2012 and 2013. It imposes a $2,300/ton threshold on Group 1 state SO_2 emissions, a $500/ton threshold on Group 2 SO_2 emissions, a $500/ton threshold on annual NO_x emissions, and a $500/ton threshold on ozone-season NO_x in TR states covered for those emissions in 2014 and each year thereafter. Because the $2,300/ton IPM analysis included all of these selected cost thresholds under the final Transport Rule, EPA relied on that IPM analysis's projected remaining state level emissions in 2012 and 2014 from all fossil units greater than 25 MW as the basis for the state budgets in those years. Hence, the values in Tables B-3 through B-5 generally represent emissions levels after the removal of significant contribution to nonattainment in an average year, and therefore they are the appropriate basis for the state budgets reflected in section VI.D of the Transport Rule preamble. In most cases, these remaining emission levels from fossil-fired units greater than 25 MW become the state budget levels. There are few exceptions and they are noted below and in the Transport Rule preamble.

As explained in section VI.D of the TR preamble, no state's 2014 budget may be larger than its 2012 budget for that pollutant. In instances where the above approach would have yielded a higher state budget in 2014 relative to its 2012 state budget, than 2014 budgets were set equal to the state's 2012 budget for that pollutant. For instance, a Group 2 state with a constant $500/ton thresholds in all years for SO_2 may have experienced upward pressure on its 2014 emissions due to emissions leakage from Group 1 states that had a higher cost threshold simultaneously imposed starting in year 2014. However, the steps above prevent such emission increases in states covered by the Transport Rule by ensuring that budgets do not increase between 2012 and 2014. Additionally, there were five states whose 2012 ozone-season emissions in this analysis were not significantly different from their 2012 base case projected emissions. EPA conducted a sensitivity analysis to confirm that if left uncapped, these states' ozone-

season emissions would increase as other states make Transport Rule-related emission reductions, due to emissions leakage. EPA is therefore setting these states' ozone-season budgets equal to their 2012 base case emissions to prevent such emission increases. Further explanation of this issue is provided in section VI.D of the Preamble.[4]
There were also a few budget adjustments made based on technical corrections described in Section VIII.A of the Transport Rule preamble. These were based on post-modeling quality assurance checks that found discrepancies in the SO_2 pollution control technology modeled for specific units in Kentucky, Michigan, and New York that did not match commenter-provided data and independent third party proprietary sources. These discrepancies affected the 2012 SO_2 budgets for Michigan and Kentucky and the 2012 and 2014 SO_2 budgets for New York.

Modeling of the Transport Rule showed scrubbers operating in 2012 on units at Monroe in Michigan and at Big Sandy in Kentucky, whereas commenters had informed the Agency that these units would not have scrubbers online by that time. As a result, EPA made technical corrections to the 2012 SO2 budgets in Michigan and Kentucky to reflect unscrubbed emissions from those units (taken from base case modeling of those units' unscrubbed operation). Therefore, the corrected 2012 SO2 budgets in Michigan and Kentucky do not reflect operation of those controls.

Modeling of the Transport Rule also showed scrubbers operating in 2012 and in 2014 on units at Dunkirk and at Huntley in New York. However, public comments showed that these units operate dry sorbent injection, not scrubbers, which would yield a lower SO2 removal than what was modeled at those units. As a result, EPA made technical corrections to the 2012 and 2014 SO2 budgets in New York to reflect a revised SO2 removal rate at those units consistent with the technology reported by commenters for those units. Therefore, the corrected 2012 and 2014 budgets in New York now reflect operation of the controls reported by commenters at the affected units.

EPA conducted a sensitivity analysis to reflect the impact of these technical corrections on projections for the Transport Rule remedy. That analysis also incorporated finalized variability limits, which were higher than those originally modeled in the main analysis. The results of this analysis are presented in Appendix F of the Regulatory Impact Analysis.

The IPM runs performed for the cost analyses are listed in Table Appendix A-1 in of this TSD. This table lists the name of each IPM run next to a description of the run. The output files of these model runs can be found in the rulemaking docket. In the TR preamble section VI.B, the emissions that reflect state emissions under particular cost thresholds analyzed are presented rounded to the nearest thousand tons. The bugets given in section VI.D of the TR preamble (which are based off tables B-3 through B-5 below) are presented rounded to the nearest ton. In Tables B-1 through B-6 the emissions are presented rounded to the nearest ton.

As noted above, EPA used the emissions shown in Table B-6 as inputs to the air quality assessment tool (AQAT) to estimate the impact that the combined reductions available from states covered under the Transport Rule, at different cost-per-ton levels,

[4] EPA made these 2012 adjustments for ozone-season NO_X budgets given that the 2012 compliance deadline is coordinated with the June 2013 maximum attainment deadline for ozone nonattainment areas. EPA made a similar review for SO_2 and annual NO_X budgets in 2014 (which is coordinated with the April 2015 maximum attainment deadline), and found that no such adjustments were necessary.

would have on air quality at downwind monitors that were identified as nonattainment and/or maintenance for purposes of the Transport Rule. Section C in this TSD describes EPA's development and use of AQAT and the results from our AQAT analysis. Section C also compares the AQAT results to those produced using the Comprehensive Air Quality Model with Extensions (CAMx).

Table B-1. 2012 & 2014 Ozone Season NO_x EGU Emissions* for Each State at Various Pollution Control Cost Thresholds per Ton of Reduction (Tons).

State	Base Case Emission Levels		$500/ton		$1,000/ton		$5,000/ton	
	2012	2014	2012	2014	2012	2014	2012	2014
Alabama	34,074	31,365	34,203	31,372	33,951	31,393	30,831	29,824
Arkansas	15,037	16,644	14,995	16,565	14,944	16,432	13,969	14,970
Florida	41,646	45,993	27,069	29,607	27,029	29,122	24,277	26,866
Georgia	29,106	19,293	28,185	18,331	28,033	18,323	25,413	17,569
Illinois	21,371	22,043	21,266	21,961	21,313	21,859	20,844	21,505
Indiana	46,877	46,086	46,123	46,471	46,190	46,174	42,769	41,374
Iowa	18,307	19,440	16,526	17,082	16,308	16,996	15,227	15,776
Kansas	16,126	13,967	13,502	10,849	13,502	10,730	12,030	9,506
Kentucky	37,588	35,296	36,687	34,957	36,221	34,573	33,548	32,483
Louisiana	13,433	13,924	13,435	13,910	13,451	13,910	13,301	13,728
Maryland	7,179	7,540	7,238	7,540	7,235	7,540	6,983	7,293
Michigan	25,989	28,037	26,058	26,250	25,771	26,180	25,381	25,168
Mississippi	10,161	11,212	10,164	11,212	10,153	11,212	9,106	9,592
Missouri	23,156	23,759	22,952	23,759	22,952	23,661	21,433	21,707
New Jersey	3,440	3,668	3,448	3,669	3,407	3,668	3,361	3,648
New York	8,336	9,031	8,329	9,035	8,420	8,910	8,039	8,525
North Carolina	22,902	20,169	22,904	20,182	22,642	19,997	21,240	18,949
Ohio	42,274	41,327	42,302	40,493	41,863	40,375	38,437	38,348
Oklahoma	31,415	31,723	21,574	22,059	20,998	21,328	20,009	19,456
Pennsylvania	52,895	54,217	52,626	54,134	52,444	53,842	49,279	49,444
South Carolina	15,145	16,586	15,108	16,351	14,946	15,958	13,594	14,745
Tennessee	15,505	12,141	15,512	12,126	15,486	12,126	14,715	11,613
Texas	64,711	65,492	63,081	64,341	62,872	64,448	60,419	62,453
Virginia	15,148	15,339	14,662	15,299	14,599	15,116	12,543	13,575
West Virginia	26,464	27,099	26,350	27,014	26,151	26,819	23,988	24,485
Wisconsin	15,876	16,048	13,971	14,134	13,928	14,035	12,412	12,897
Total	**654,161**	**647,439**	**618,267**	**608,702**	**614,807**	**604,728**	**573,150**	**565,498**

*Source: Integrated Planning Model run by EPA, 2011. See Appendix A for list and description of these IPM runs. Emissions have been rounded to the nearest ton. Emissions shown for all fossil-fired units greater than 25 MW when only an ozone season cost constraint is applied to Transport Rule States. Costs are in 2007$.

Table B-2. 2012 and 2014 Annual NO_x EGU Emissions* for Each State at Various Pollution Control Cost Thresholds per Ton of Reduction (Tons).

State	Base Case Emission Levels		$500/ton		$1,000/ton		$2,500/ton	
	2012	2014	2012	2014	2012	2014	2012	2014
Alabama	82,005	74,937	78,468	71,685	77,859	71,670	75,292	70,060
Georgia	66,384	47,808	63,073	40,809	62,921	40,712	59,713	39,457
Illinois	51,969	54,661	48,150	50,541	48,160	50,237	48,665	49,385
Indiana	119,625	116,552	109,506	108,187	108,610	107,176	108,241	99,876
Iowa	42,563	44,614	38,262	39,539	37,875	39,247	36,647	37,319
Kansas	37,106	32,390	30,991	25,075	30,759	24,815	30,194	23,190
Kentucky	88,136	83,481	85,396	82,657	84,572	81,024	82,150	78,087
Maryland	16,602	17,444	16,590	17,444	16,496	17,409	16,380	17,396
Michigan	60,594	64,345	60,725	61,088	60,482	60,877	59,991	60,110
Minnesota	36,833	37,952	29,588	30,441	29,537	30,432	29,427	30,294
Missouri	53,199	54,528	52,892	54,411	52,827	54,103	50,799	51,036
Nebraska	42,985	43,410	26,481	26,741	26,108	26,374	25,497	20,611
New Jersey	7,391	7,858	7,398	7,866	7,264	7,867	7,124	7,740
New York	17,556	18,505	17,551	18,519	17,643	18,378	17,317	18,290
North Carolina	51,902	46,130	52,021	45,755	51,584	45,617	50,856	43,777
Ohio	100,420	99,389	98,473	94,680	97,444	94,143	94,702	91,686
Pennsylvania	129,125	132,299	120,709	124,106	120,307	123,942	119,063	115,990
South Carolina	34,635	37,862	34,548	37,549	34,305	37,029	32,640	35,996
Tennessee	37,674	29,256	37,676	29,315	37,654	29,395	36,450	28,680
Texas	136,124	140,788	133,141	138,150	132,861	137,582	131,931	136,062
Virginia	34,567	35,798	33,490	34,785	33,178	34,642	32,416	27,610
West Virginia	61,792	64,182	61,702	64,102	61,560	63,831	59,906	60,555
Wisconsin	36,701	36,904	32,078	32,267	31,975	32,008	30,811	30,766
Total	**1,345,888**	**1,321,093**	**1,268,907**	**1,235,710**	**1,261,982**	**1,228,509**	**1,236,210**	**1,173,972**

*Source: Integrated Planning Model run by EPA, 2011. See Appendix A for list anda description of these IPM runs. Emissions have been rounded to the nearest ton. Emissions shown for all fossil-fired units greater than 25 MW when only an ozone season cost constraint is applied to Transport Rule States. Costs are in 2007$.

Table B-3. 2012 & 2014 Ozone Season NO_x EGU Emissions from all Fossil Units Greater than 25 MW at Escalating SO_2 Cost Thresholds from Final Cost Curve Analysis (Tons).

State	Base Case		$500		$1,600		$2,300		$2,800		$3,300		$10,000	
	2012	2014	2012	2014	2012	2014	2012	2014	2012	2014	2012	2014	2012	2014
Alabama	34,074	31,365	32,285	30,954	32,091	31,481	31,746	31,499	31,749	31,509	31,749	31,513	35,056	31,624
Arkansas	15,037	16,644	15,087	16,652	15,087	16,759	15,087	16,794	15,087	16,794	15,087	16,794	16,690	16,867
Florida	41,646	45,993	27,888	29,657	27,825	29,925	27,825	29,894	27,825	29,700	27,825	29,700	29,034	30,143
Georgia	29,106	19,293	27,949	18,184	27,948	18,259	27,944	18,279	27,878	18,444	27,878	18,449	29,784	18,320
Illinois	21,371	22,043	21,208	21,791	21,212	21,589	21,208	21,383	21,208	21,222	21,202	21,010	19,936	19,536
Indiana	46,877	46,086	47,788	46,249	47,348	46,734	47,351	46,175	47,357	45,774	47,365	45,482	44,011	42,999
Iowa	18,307	19,440	16,532	17,135	16,532	16,848	16,532	16,207	16,532	16,174	16,532	16,172	14,055	14,570
Kansas	16,126	13,967	13,536	10,590	13,536	10,709	13,536	10,998	13,536	11,164	13,536	11,207	14,116	11,392
Kentucky	37,588	35,296	36,204	34,515	36,204	32,952	36,167	32,674	36,178	32,729	36,178	31,650	33,623	24,214
Louisiana	13,433	13,924	13,581	13,925	13,582	13,861	13,614	13,897	13,509	13,998	13,513	14,015	13,898	14,204
Maryland	7,179	7,540	7,285	7,540	7,285	7,276	7,284	7,248	7,164	7,141	7,164	7,141	6,781	6,911
Michigan	25,989	28,037	25,757	26,032	25,752	25,550	25,752	24,727	25,752	24,427	25,752	24,566	23,955	22,388
Mississippi	10,161	11,212	10,644	11,244	10,644	11,345	10,644	11,345	10,642	11,345	10,642	11,345	11,385	11,486
Missouri	23,156	23,759	22,762	23,299	22,762	22,136	22,762	21,073	22,762	20,679	22,762	20,072	18,284	17,430
New Jersey	3,440	3,668	3,377	3,684	3,377	3,661	3,382	3,652	3,383	3,646	3,383	3,646	4,396	3,287
New York	8,336	9,031	8,358	9,045	8,357	9,029	8,331	9,032	8,359	9,030	8,359	9,028	8,214	8,983
North Carolina	22,902	20,169	22,241	19,707	22,209	18,454	22,168	18,455	22,172	18,442	22,172	18,104	17,657	16,767
Ohio	42,274	41,327	40,114	39,081	40,136	36,890	40,063	37,792	39,907	37,674	39,867	36,758	27,779	29,813
Oklahoma	31,415	31,723	21,836	22,063	21,835	22,110	21,835	22,110	21,859	22,110	21,840	22,110	21,822	22,321
Pennsylvania	52,895	54,217	52,207	53,407	52,242	52,251	52,201	51,912	52,166	51,755	52,150	51,689	44,186	48,207
South Carolina	15,145	16,586	14,165	15,711	14,050	15,696	13,909	16,060	13,943	16,181	13,943	16,224	16,673	16,400
Tennessee	15,505	12,141	14,908	9,700	14,908	8,443	14,908	8,016	14,908	8,016	14,908	8,019	10,585	8,803
Texas	64,711	65,492	63,010	64,369	63,042	64,432	63,043	64,450	63,043	64,462	62,856	64,464	63,872	64,547
Virginia	15,148	15,339	14,437	15,387	14,449	14,823	14,452	15,250	14,458	14,930	14,452	14,946	11,721	13,712
West Virginia	26,464	27,099	25,418	27,014	25,434	24,475	25,283	23,291	25,092	23,655	25,092	24,364	17,932	22,778
Wisconsin	15,876	16,048	13,771	13,867	13,718	13,631	13,704	13,216	13,705	12,802	13,703	12,371	11,564	9,465
Total	654,161	647,439	612,348	600,802	611,565	589,319	610,731	585,429	610,174	583,803	609,910	580,839	567,009	547,167

*Source: Integrated Planning Model run by EPA, 2011. See Appendix A for list and description of these IPM runs. Emissions have been rounded to the nearest ton. These "final cost curve" runs have NO_x and ozone season NO_x cost thresholds at $500/ton (all years), SO_2 Group 2 at $500/ton (all years), and SO_2 Group 1 (2012-2013) at $500/ton. The escalating cost thresholds identified in the column headers above only apply starting in 2014 for Group 1 SO_2 states. Costs are in 2007$

Table B-4. 2012 & 2014 NO_x EGU Emissions from all Fossil Units Greater than 25 MW at Escalating SO_2 Cost Thresholds from Final Cost Curve Analysis (Tons).

State	Base Case		$500		$1,600		$2,300		$2,800		$3,300		$10,000	
	2012	**2014**	**2012**	**2014**	**2012**	**2014**	**2012**	**2014**	**2012**	**2014**	**2012**	**2014**	**2012**	**2014**
Alabama	82,005	74,937	73,772	70,582	73,127	71,787	72,691	71,962	72,748	72,033	72,538	72,088	80,949	72,410
Georgia	66,384	47,808	61,601	40,349	62,014	40,425	62,010	40,540	61,948	40,706	61,421	40,742	66,945	40,743
Illinois	51,969	54,661	47,890	50,293	47,874	49,495	47,872	48,478	47,874	48,282	47,869	48,171	43,323	44,244
Indiana	119,625	116,552	110,396	107,081	109,790	109,291	109,726	108,424	109,642	107,305	109,592	106,426	101,584	99,243
Iowa	42,563	44,614	38,335	39,549	38,335	38,762	38,335	37,498	38,288	36,709	38,288	36,637	32,212	34,101
Kansas	37,106	32,390	30,714	24,379	30,714	24,782	30,714	25,560	30,714	25,779	30,714	25,811	32,312	26,063
Kentucky	88,136	83,481	85,200	81,786	85,124	77,999	85,086	77,238	85,034	76,974	84,905	73,977	72,916	56,152
Maryland	16,602	17,444	16,634	17,364	16,634	16,604	16,633	16,574	16,513	16,330	16,513	16,330	15,633	15,906
Michigan	60,594	64,345	60,200	60,541	60,193	59,135	60,193	57,812	60,193	57,677	60,193	57,562	55,437	51,034
Minnesota	36,833	37,952	29,573	30,377	29,571	31,021	29,572	31,345	29,573	31,354	29,529	31,350	30,986	31,818
Missouri	53,199	54,528	52,373	53,633	52,373	50,742	52,374	48,717	52,374	47,277	52,374	46,505	42,689	39,797
Nebraska	42,985	43,410	26,444	26,546	26,440	26,739	26,440	26,739	26,478	26,739	26,478	26,739	26,489	26,822
New Jersey	7,391	7,858	7,245	7,903	7,245	7,851	7,266	7,825	7,257	7,800	7,263	7,795	9,477	7,025
New York	17,556	18,505	17,536	18,547	17,534	18,531	17,543	18,549	17,569	18,544	17,574	18,542	17,119	17,951
North Carolina	51,902	46,130	50,960	44,897	51,020	41,916	50,587	41,553	50,586	41,049	50,587	40,040	39,839	37,982
Ohio	100,420	99,389	92,500	91,476	92,822	86,866	92,703	87,493	92,555	87,358	92,382	84,866	64,064	69,029
Pennsylvania	129,125	132,299	119,984	123,299	120,031	120,528	119,986	119,194	119,799	118,829	119,788	118,853	100,823	110,275
South Carolina	34,635	37,862	33,143	36,191	32,856	36,355	32,498	36,821	32,531	37,110	32,532	37,318	38,093	37,705
Tennessee	37,674	29,256	36,208	23,458	36,208	20,381	35,703	19,337	34,092	19,329	33,596	19,343	23,995	20,743
Texas	136,124	140,788	133,596	138,268	133,671	138,358	133,595	138,410	132,835	138,413	132,223	138,415	136,850	138,400
Virginia	34,567	35,798	33,133	35,607	33,156	34,790	33,242	34,903	33,246	34,606	33,011	34,704	26,351	31,083
West Virginia	61,792	64,182	59,606	63,625	59,622	56,738	59,472	54,582	59,280	55,301	59,280	56,565	40,804	52,565
Wisconsin	36,701	36,904	31,828	31,640	31,716	31,398	31,628	30,398	31,633	29,207	31,533	28,090	26,042	21,663
Total	**1,345,888**	**1,321,093**	**1,248,871**	**1,217,391**	**1,248,070**	**1,190,494**	**1,245,869**	**1,179,952**	**1,242,762**	**1,174,711**	**1,240,183**	**1,166,869**	**1,124,932**	**1,082,754**

*Source: Integrated Planning Model run by EPA, 2011. See Appendix A for list and description of these IPM runs. Emissions have been rounded to the nearest ton. These "final cost curve" runs have NO_x and ozone season NO_x cost thresholds at $500/ton (all years), SO_2 Group 2 at $500/ton (all years), and SO_2 Group 1 (2012-2013) at $500/ton. The escalating cost thresholds identified in the column headers above only apply starting in 2014 for Group 1 SO_2 states. Costs are in 2007$

Table B-5. 2012 & 2014 SO_2 EGU Emissions from all Fossil Units Greater than 25 MW at Escalating SO_2 Cost Thresholds from Final Cost Curve Analysis (Tons).

State	Base Case		$500		$1,600		$2,300		$2,800		$3,300		$10,000	
	2012	2014	2012	2014	2012	2014	2012	2014	2012	2014	2012	2014	2012	2014
Alabama	455,503	417,009	210,559	200,573	221,896	226,299	216,033	213,258	219,088	213,991	223,903	235,837	234,732	189,743
Georgia	405,933	169,702	157,474	94,105	158,455	94,142	158,527	95,231	159,484	95,484	158,022	94,946	174,898	97,942
Illinois	485,417	137,522	230,622	134,311	233,080	129,881	234,889	124,123	234,889	117,375	234,876	101,789	160,616	35,735
Indiana	776,359	711,265	285,584	245,191	294,517	178,525	285,424	161,111	285,099	152,954	282,070	120,532	159,737	69,382
Iowa	121,663	127,354	97,556	112,000	107,085	77,765	107,085	75,184	106,969	66,507	106,969	44,711	56,120	12,852
Kansas	68,490	69,767	41,528	55,250	41,528	57,372	41,528	60,811	41,528	61,193	41,528	61,360	45,235	45,465
Kentucky	520,531	487,990	176,229	160,567	185,426	126,374	189,335	106,284	189,830	102,868	191,235	88,755	75,486	45,958
Maryland	49,942	42,926	30,123	32,187	30,123	28,288	30,120	28,203	30,072	25,712	30,072	23,609	25,048	18,368
Michigan	252,411	265,611	194,537	206,173	194,537	188,646	194,537	143,995	194,537	105,223	194,537	93,569	115,742	23,884
Minnesota	64,524	66,268	41,981	43,336	41,981	45,191	41,981	45,638	41,981	45,628	41,880	45,618	43,119	44,257
Missouri	375,771	381,939	194,109	212,349	207,466	173,022	207,466	165,941	207,466	109,378	207,466	83,546	138,781	21,387
Nebraska	70,754	71,821	65,054	68,214	65,052	70,223	65,052	70,223	65,079	70,223	65,079	70,223	65,220	66,051
New Jersey	26,346	38,857	5,583	7,069	5,583	7,008	5,574	6,611	5,554	6,506	5,554	6,469	5,374	4,602
New York	51,243	40,416	20,550	20,657	20,578	20,037	20,497	11,823	20,515	10,928	20,515	9,871	14,917	8,105
North Carolina	144,554	120,441	117,658	103,780	134,827	60,725	136,881	57,620	136,942	48,683	136,942	40,047	35,412	30,440
Ohio	871,401	831,648	311,386	293,727	325,562	174,809	310,230	137,077	309,272	123,021	308,557	114,919	99,078	65,201
Pennsylvania	493,206	507,360	278,972	294,283	279,394	164,089	278,651	112,021	277,647	107,249	278,771	101,520	75,867	74,761
South Carolina	184,045	209,538	82,993	92,761	84,431	99,853	88,620	103,371	89,183	104,311	89,180	104,462	106,928	104,924
Tennessee	324,372	284,463	143,276	82,154	150,768	63,323	148,150	58,833	144,319	58,810	142,874	58,802	65,994	24,360
Texas	445,715	452,978	244,281	280,938	244,281	281,706	243,954	283,743	242,082	281,325	239,973	281,325	282,288	242,508
Virginia	80,889	64,917	70,810	58,969	70,820	50,806	70,820	35,057	70,758	33,380	69,647	31,563	18,870	15,963
West Virginia	535,586	497,398	146,239	157,335	148,095	121,751	146,174	75,668	144,206	74,373	143,472	71,505	47,973	55,246
Wisconsin	131,199	124,862	79,833	51,443	79,664	47,172	79,480	40,126	79,508	37,515	79,066	33,727	55,015	13,805
Total	**6,935,854**	**6,122,052**	**3,226,937**	**3,007,372**	**3,325,149**	**2,487,007**	**3,301,008**	**2,211,952**	**3,296,008**	**2,052,637**	**3,292,188**	**1,918,705**	**2,102,450**	**1,310,939**

*Source: Integrated Planning Model run by EPA, 2011. See Appendix A for list and description of these IPM runs. Emissions have been rounded to the nearest ton. These "final cost curve" runs have NO_x and ozone season NO_x cost thresholds at $500/ton (all years), SO_2 Group 2 at $500/ton (all years), and SO_2 Group 1 (2012-2013) at $500/ton. The escalating cost thresholds identified in the column headers above only apply starting in 2014 for Group 1 SO_2 states. Costs are in 2007$

Table B-6. 2012 & 2014 Transport Rule State SO_2 EGU Emission Total Used in AQAT Modeling (Tons)

State	Group	Base Case		$500		$1,600		$2,300		$2,800		$3,300		$10,000	
		2012	2014	2012	2014	2012	2014	2012	2014	2012	2014	2012	2014	2012	2014
Alabama	2	455,825	417,340	210,886	200,905	222,223	226,634	216,360	213,593	219,414	214,326	224,230	236,172	235,074	190,078
Georgia	2	406,279	170,288	157,838	94,691	158,820	94,745	158,891	95,834	159,849	96,087	158,386	95,549	175,457	98,523
Illinois	1	489,140	141,606	235,127	138,815	237,585	134,386	239,393	128,997	239,393	122,249	239,381	106,945	165,772	40,892
Indiana	1	789,116	727,786	299,438	262,386	308,439	196,258	299,346	179,539	299,021	171,784	295,991	139,546	175,756	89,307
Iowa	1	127,102	133,083	102,989	117,830	112,450	83,661	112,450	81,137	112,334	72,460	112,334	50,664	64,589	23,429
Kansas	2	68,541	69,819	41,587	55,308	41,587	57,432	41,587	60,870	41,587	61,252	41,587	61,419	45,295	45,524
Kentucky	1	520,546	488,006	176,244	160,582	185,441	126,390	189,350	106,299	189,845	102,883	191,251	88,770	75,502	45,973
Maryland	1	49,942	42,926	30,123	32,187	30,123	28,288	30,120	28,203	30,072	25,712	30,072	23,609	25,048	18,368
Michigan	1	255,038	269,434	197,385	210,163	197,384	192,884	197,380	148,232	197,380	109,506	197,380	97,932	120,259	29,350
Minnesota	2	67,816	70,937	45,321	47,720	45,300	49,589	45,300	50,213	45,300	50,203	45,199	50,193	46,972	49,281
Missouri	1	383,314	390,287	201,504	221,689	214,803	182,508	214,803	175,480	214,861	118,917	214,861	93,085	149,341	41,805
Nebraska	2	71,905	73,073	66,204	69,466	66,203	71,475	66,203	71,475	66,230	71,475	66,230	71,475	66,371	67,303
New Jersey	1	26,346	38,857	5,583	7,069	5,583	7,008	5,574	6,611	5,554	6,506	5,554	6,469	5,374	4,602
New York	1	56,461	42,887	26,006	23,181	26,041	22,618	25,960	14,404	25,735	13,399	25,735	12,342	20,095	10,588
North Carolina	1	148,606	126,048	122,063	109,612	139,232	66,643	141,263	63,577	141,311	54,717	141,311	46,081	40,187	36,326
Ohio	1	882,559	851,199	327,015	313,193	341,192	202,443	325,375	166,691	324,417	153,471	323,702	145,431	130,251	98,812
Pennsylvania	1	495,463	509,650	281,272	296,596	281,681	166,402	280,938	114,431	279,934	109,658	281,058	103,929	78,272	77,170
South Carolina	2	186,355	213,281	85,479	96,504	86,917	103,596	91,106	107,114	91,669	108,055	91,666	108,660	109,715	109,122
Tennessee	1	324,377	284,468	143,281	82,159	150,773	63,328	148,155	58,838	144,324	58,815	142,879	58,807	66,001	24,366
Texas	2	446,006	453,332	244,613	281,298	244,613	282,066	244,287	284,132	242,414	281,721	240,305	281,721	282,685	242,905
Virginia	1	92,468	77,256	83,019	71,505	83,029	63,367	83,029	47,639	82,772	45,962	81,661	44,145	31,527	28,545
West Virginia	1	536,695	498,507	147,349	158,445	149,205	122,860	147,284	76,778	145,315	75,483	144,582	72,615	49,083	56,356
Wisconsin	1	135,828	130,538	85,168	57,418	85,110	53,147	84,925	46,205	84,895	43,585	84,453	39,797	60,984	19,431
Total		7,015,727	6,220,607	3,315,495	3,108,724	3,413,731	2,597,726	3,389,078	2,326,289	3,383,625	2,168,226	3,379,807	2,035,357	2,219,608	1,448,054

*Source: Integrated Planning Model run by EPA, 2011. See Appendix A for list and description of these IPM runs. Emissions are shown for all fossil and biomass units. These "final cost curve" runs have NO_x and ozone season NO_x cost thresholds at $500/ton (all years), SO_2 Group 2 at $500/ton (all years), and SO_2 Group 1 (2012-2013) at $500/ton. The escalating cost thresholds identified in the column headers above only apply starting in 2014 for Group 1 SO_2 states. Costs are in 2007$

C. Analysis of Significant Contribution Using the Air Quality Assessment Tool

EPA has defined significant contribution to nonattainment and interference with maintenance using a multi-factor test (described in section VI.D of the preamble) which is based on both cost and air quality factors. A key quantitative input for determining the amount of significant contribution is the predicted downwind ambient air quality impacts of upwind EGU emission reductions under the SO_2 and NO_X cost thresholds. Time and resource limitations (in particular the amount of time needed to set up, run the CAMx model, and analyze the results for a single model run) precluded the use of air quality modeling for all but a few emissions scenarios. Because EPA needed to evaluate emission reductions under several different SO_2 cost thresholds, it was not possible to use CAMx air quality modeling to evaluate all cases.[5]

EPA thus used a simplified air quality assessment tool (AQAT) to estimate the downwind air quality impacts from the SO_2 cost thresholds. For the SO_2 cost thresholds, the state-by-state EGU emissions are projected using EPA's IPM model under a given cost threshold of emission reductions (see section B of this TSD for details about the IPM model runs and for the emission projections). The air quality impacts of these cost thresholds are then estimated using AQAT. The simplified tool allows the Agency to analyze many more SO_2 cost thresholds than would otherwise be possible. The remainder of section C of this document will:

- Present an introduction and overview of AQAT;
- Describe the construction of AQAT;
- Provide the results of the SO_2 cost threshold analyses;
- Compare the AQAT estimates and CAMx results for sulfate and total $PM_{2.5}$ for two emissions scenarios where CAMx modeling was performed (i.e., the 2014 base case and 2014 remedy); and
- Describe the results of an analysis of emissions "leakage" for 2012 performed using AQAT.

1. Introduction: Development of the air quality assessment tool.

AQAT was developed specifically for use in the Transport Rule significant contribution analysis. EPA described AQAT in detail in the proposed Transport Rule and took comment on the tool. For this final rule, EPA refined both the construction and application of AQAT. Significant changes made since proposal and in response to comments include:

- Reliance on CAMx modeling for the evaluation of downwind ozone concentrations and the nitrate component of ambient $PM_{2.5}$ (i.e., AQAT was not used to estimate air quality changes due to emission changes in NO_x);
- Calibration of AQAT's predicted change in sulfate concentrations to change in SO_2 emissions using CAMx. This calibration is receptor-specific and is based on the changes in SO_2 emissions and resulting sulfate concentrations between the 2012 base

[5] For similar reasons, EPA used AQAT to assess the air quality impacts of variability in emissions. (See the Power Sector Variability Final Rule TSD).

case and an AQAT calibration scenario[6] in 2014 (for more details about this scenario, see the footnote and the brief description below).

- Use of seasonal contributions, and seasonal relative response factors, in developing the relationship between SO_2 reductions and 24-hour $PM_{2.5}$ concentrations; and Application of these seasonal relative response factors to estimate annual and 24-hour PM2.5 average and maximum design values for the cost levels analyzed.

As described in section VI.B of the preamble, EPA determined that the $500/ton threshold for upwind annual and ozone-season NO_x control is appropriate for the final Transport Rule. Because this threshold corresponds to the NO_x control strategy modeled in the AQAT calibration scenario, EPA used the CAMx modeling from this scenario directly rather than develop an AQAT for ozone. Additionally, EPA used the nitrate predictions from the CAMx modeling of the AQAT calibration scenario to calculate the nitrate component of annual and 24-hour $PM_{2.5}$ design values at the various SO_2 cost thresholds analyzed for the final Transport Rule. EPA created and used two separate versions of AQAT (annual and 24-hour $PM_{2.5}$) to estimate the impact of the SO_2 emission reductions on ambient sulfate concentrations for the two NAAQS, respectively. For both versions of AQAT, the sulfate estimates were combined with CAMx estimates of nitrate and other pollutant species calculated from the AQAT calibration scenario to estimate concentrations of total $PM_{2.5}$. Most of the steps used in the construction of the annual and 24-hour $PM_{2.5}$ versions of AQAT are the same. Consequently, when EPA refers to a single AQAT, the description applies to both the annual and 24-hour versions of the tool. Step-by-step descriptions of these tools are found in section C.2 of this document. Where differences in the construction of the tools are present, the differences are described.

A critical factor in AQAT is the establishment of a relationship between SO_2 emission reductions and reductions in sulfate. For the purposes of developing and using AQAT to compare the air quality impacts of SO_2 emission reductions under various SO_2 cost thresholds, we determine the relationship between changes in emissions and changes in sulfate contributions on a receptor-by-receptor basis. Specifically, as a start EPA assumed that within the range of total SO_2 emissions being considered (as defined by the SO_2 cost thresholds), a change in SO_2 emissions leads to a proportional change in downwind sulfate contributions. This proportional relationship was then modified using calibration factors based on air quality modeling, as described below.

Within AQAT, the relationships between upwind emissions and downwind air quality are defined using the 2012 base case contribution air quality modeling and a 2014 AQAT calibration scenario[6]. As described in the Air Quality Modeling Final Rule TSD, CAMx state-by-state source-apportionment modeling was used to quantify the contributions to sulfate at PM2.5 monitoring sites due to SO_2 emissions from each upwind state for the 2012 base case emission scenario. For example, from the output of the CAMx source apportionment modeling, we know

[6] An integral input to the creation and use of AQAT was CAMx air quality modeling of the AQAT calibration scenario. This scenario was created prior to the development of AQAT for the final Transport Rule and it's EGU emissions modeling reflects the geography and cost thresholds from the preferred remedy of the proposed Transport Rule. Specifically, this scenario uses IPM to model cost thresholds of $500/ton for annual and ozone-season NO_x for states proposed to be regulated for $PM_{2.5}$ and ozone respectfully in the proposed Transport Rule; $500/ton for SO_2 in $PM_{2.5}$ Group 2 states from the proposed Transport Rule; and $2,000/ton for SO_2 in $PM_{2.5}$ Group 1 states from the proposed Transport Rule. Note that the geography and SO_2 cost thresholds for this scenario differ from the geography and SO_2 cost thresholds for the final Transport Rule.

the annual average sulfate contribution at a downwind monitor resulting from the specific SO_2 emissions in the 2012 base case from a particular upwind state. Similarly, we also know the sulfate contributions for each quarter of the year (January—March, April—June , July—September , and October—December). In AQAT, we associate a change in emissions from that upwind state with a particular change in its downwind contribution. In "uncalibrated" AQAT, for example, we assume that a 20% decrease in the upwind state's emissions leads to a 20% decrease in its downwind contribution. This relationship is calibrated using emission reductions from the 2012 base case to the 2014 AQAT calibration scenario by calculating the relationship between the relative change in sulfate at each receptor using CAMx air quality modeling and the relative change in sulfate at each receptor using AQAT. This AQAT calibration scenario as described further in the Air Quality Modeling Final Rule TSD,reflected SO_2 and NO_x emission reductions of similar stringency and from the same geography as the Transport Rule proposal. Using this relationship, it was possible to calibrate AQAT's sulfate response for use in assessing sulfate under various SO_2 cost thresholds. This is described further in section C.2 of this document. For the example above, where a 20% reduction in emissions resulted in a 20% decrease in contribution, using "calibrated" AQAT may yield a 15% reduction in concentration from the 20% reduction in emissions (as derived directly from the emission reduction and concentration change from the 2012 base case to the 2014 AQAT calibration scenario).

For the proposal AQAT was applied assuming a linear relationship[7] between reductions in upwind SO_2 emissions and air quality improvements at downwind monitors and that this linearity held to the point that zero SO_2 emissions yield zero sulfate formation. However, for the final Transport Rule, this relationship is now calibrated for the the range of emission reductions examined by EPA.

In the application of AQAT, we assume that the reduction of a ton of emissions of SO_2 from the upwind state has an equivalent air quality effect downwind (on an air quality impact per ton basis), regardless of source sector or the location of the particular emission source within the state where the ton was reduced. For example, reducing one ton of SO_2 emissions from the power sector is assumed to have the same downwind sulfate reduction as reducing one ton of SO_2 emissions of from the mobile source sector. Commenters on the proposed Transport Rule suggested that EPA develop sector-specific contribution factors for use in AQAT. However,

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[7] As described in the proposed Transport Rule Analysis to Quantify Significant Contribution TSD, understanding the relationship between emissions and air quality involves looking at some of the chemical reactions involved in the formation of $PM_{2.5}$. $PM_{2.5}$ concentration is comprised of several chemical species including related forms of particulate sulfate and particulate nitrate. The atmospheric chemical reactions that convert SO_2 to particulate sulfate are central to understanding the relationship between emissions and particulate formation. Both gas-phase and aqueous-phase processes can be important in the formation of particulates.

In both phases, the reaction is presumably dependent on complex effects from oxidants, possibly leading to a nonlinear response in sulfate formation (particularly for the aqueous phase). In the gas phase, the reaction depends on hydroxyl radical (OH) concentrations, which depend indirectly on NO_X and VOC concentrations, as well as sunlight intensity. In the aqueous phase, the rate of formation in solution is dependent on oxidants in solution such as H_2O_2 and O_3. During certain times and situations, such as the winter months when H2O2 concentrations may be low and SO_2 concentrations are high, the response in sulfate formation may be nonlinear. Some of the factors and reagents (among others) affecting the reactions include NH_3, NO_X and VOC concentrations, sunlight intensity, and temperature. (Atmospheric Chemistry and Physics: From Air Pollution to Climate Change (2nd Edition). 2006. John H. Seinfeld & Spyros N. Pandis. Published by John Wiley & Sons, Inc., Hoboken, New Jersey).

The air quality assessment tool was not designed or intended to account for the non-linear relationships between emissions and air quality. In contrast to the assessment tool, the CAMx modeling explicitly accounts for interactions and nonlinearities in the atmospheric reactions, the effects of transport and diffusion, and the uneven geographic distribution of sources and controls across a state.

relying on the contribution from all sources is reasonable for the analysis of EGU costs and reductions because total SO_2 emissions in 2012 are dominated by emissions from EGUs.

While less rigorous than the air quality models used for attainment demonstrations, EPA has established that AQAT is a cost-effective tool for estimating the downwind sulfate reductions due to upwind SO_2 emission reductions for the air quality input to the multi-factor test for the final Transport Rule. The evidence substantiating this is found in section C.4 in this TSD.

Section C.2, below, is a technical explanation of the construction of AQAT. Readers who prefer to access the results of the analysis using the AQAT tool are directed to section C.3. Comparisons between AQAT and the CAMx modeling for the 2014 base case and the 2014 remedy can be found in section C.4

2. Details on the construction of the air quality assessment tool.

(a) Overview of AQAT.

This section describes the step-by-step development process for AQAT. In AQAT, EPA links state-by-state SO_2 emission reductions (from IPM) with CAMx modeled sulfate contributions in order to predict PM2.5 concentrations at different cost thresholds at monitoring sites with projected nonattainment and/or maintenance problems in the 2012 base case. The reduction in sulfate contributions and resulting air quality improvement were then considered in a multi-factor test for defining significant contribution to nonattainment and interference with maintenance. In the analysis for a given receptor, emissions were reduced in only those upwind states that were "linked" to that receptor (i.e., contributed an air quality impact at or above the 1 percent -- of the NAAQS standard -- air quality threshold) as well as the state that contained that receptor (regardless of that state's contribution). For a discussion of the 1% threshold, see section V.D of the preamble.

Specifically, the key estimates from AQAT for each receptor are:

- The sulfate contribution as a function of emissions at each cost threshold, for each upwind state that is contributing above the 1 percent air quality threshold and the state containing the receptor.
- The sulfate contribution under base case SO_2 emissions, for each upwind state that is not above the 1 percent air quality threshold for that receptor. These base level emissions may be reduced in future years (i.e., 2014) compared to the 2012 base case level due to EGU, mobile source, and other source-sector reductions.
- The non-sulfate concentrations under emissions modeled for the 2014 AQAT calibration scenario.

The results of the AQAT analysis for each cost threshold can be found in section C.3 of this document.

(b) Data used to construct AQAT for the final Transport Rule.

Several data sources were used to construct the calibrated AQAT for the final Transport Rule. Three data sources provide the necessary initial information to construct the uncalibrated versions of annual and 24-hour $PM_{2.5}$ AQAT. The uncalibrated annual and 24-hour $PM_{2.5}$

versions of AQAT were used to create AQAT estimates of sulfate response under SO_2 and NO_x emissions defined by the AQAT calibration scenario. The datasets required to construct the annual and 24-hour versions of AQAT included: the 2012 base case SO_2 emission inventories from all source sectors used in the source apportionment CAMx air quality modeling; the CAMx 2012 contributions for each upwind state to each downwind receptor; and the 2014 AQAT calibration scenario SO_2 emissions inventories from all source sectors. An additional dataset, 2014 sulfate concentrations from CAMx for the AQAT calibration scenario, was used to compare the AQAT-estimated sulfate concentrations for this scenario to the corresponding air quality modeling results, and develop calibration factors to align the response of sulfate to changes in SO_2 emissions in AQAT with the response predicted by CAMx.. These calibration factors were then used to create a "calibrated" AQAT. Finally, EGU SO_2 emissions (from IPM) at each cost threshold were used to generate AQAT air quality results using calibrated AQAT. The base case emissions inventories for 2012 and 2014, as well as the CAMx 2012 source apportionment air quality modeling results are discussed in preamble sections V.C and V.D, respectively. The EGU emissions for each cost threshold (projected using IPM) including the base case are listed in Table B-6 and described in section B of this TSD. To construct the annual PM2.5 version of AQAT, the emissions and CAMx air quality modeling estimates were at an annual time-scale. To construct the 24-hour PM2.5 version of AQAT, both the emissions and CAMx air quality modeling estimates were at a quarterly time-scale.

As described in section C.2.(c).5. of this TSD, for estimating the design values in the 24-hour $PM_{2.5}$ version of AQAT, an additional data set was necessary, the PM2.5 components (including sulfate) for 8 days in each quarter for each year between 2003-2007 projected to the 2012 base case and the 2014 AQAT calibration scenario case.

As described in the Air Quality Modeling Final Rule TSD and section V.D of the preamble, the air quality contributions and emissions were modeled for the following 38 states: Alabama, Arkansas, Connecticut, Delaware, District of Columbia[8], Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Vermont, Virginia, West Virginia, and Wisconsin. Thus, in AQAT, these states had the possibility of making reductions in emissions leading to changes in air quality contributions at the downwind receptors. Additionally, due to the modeling domain, AQAT is only able to estimate changes in $PM_{2.5}$ concentrations from monitors within these states. AQAT does not quantify contributions from states outside the CAMx modeling domain used for the Transport Rule (see the Air Quality Modeling Final Rule Technical Support Document). Therefore, the contributions and emissions from all other states were not varied in evaluating SO_2 cost thresholds.

(c) Detailed outline of the process for constructing and utilizing AQAT for the final approach.

The annual and 24-hour $PM_{2.5}$ versions of AQAT were created and used in a multi-step process. First, annual and 24-hour $PM_{2.5}$ versions of AQAT were created specifically for calibration. As described in the following paragraphs, the 24-hour version of AQAT simulated

[8] Maryland was treated as a separate state in this analysis, rather than as combined with the District of Columbia. Its emissions were totaled separately and the changes in emissions occurring at different marginal costs were applied to upwind contributions from Maryland alone.

each of four quarters in the a to represent seasonal differences in the response of sulfate to reductions in emissions of SO_2. Next, the relative sulfate response from AQAT was calibrated to the sulfate response from CAMx using the change in emissions from the 2012 base case to the 2014 AQAT calibration scenario. This was done on an annual basis for the annual $PM_{2.5}$ version of AQAT and on a quarterly basis for the 24-hour $PM_{2.5}$ version of AQAT. Next, the calibrated annual and 24-hour versions of AQAT were used to evaluate the sulfate response of emission reductions for each SO_2 cost threshold assessed. For the annual PM2.5 AQAT, at each cost threshold, the sulfate values were combined with other $PM_{2.5}$ constituents from the AQAT calibration scenario resulting in estimated annual PM2.5 design values. An additional step was necessary in the 24-hour $PM_{2.5}$ AQAT to calculate final design values, which was to project the adjusted sulfate change in each quarter to the representative modeled "days[9]" in each quarter using relative response factors. For each day, the other $PM_{2.5}$ constituents were added using the estimates from the AQAT calibration scenario. For the 24-hour AQAT, for each projected year, the 98th percentile value was selected. The 98th percentile values were then used to predict 2014 design values for 24-hour $PM_{2.5}$. This section describes the details behind these steps.[10]

As summarized above, one key difference between the 24-hour $PM_{2.5}$ AQAT used in the analysis for the proposed and final Transport Rule was the refinement of the SO_2 to sulfate response, by season. For the 24-hour $PM_{2.5,}$ version of AQAT used for the final Transport Rule, 4 quarterly-specific components for estimating seasonal responses for 24-hour $PM_{2.5}$ assessments were created. In response to public comment on the CAMx air quality estimates from the proposal and the comparison with the AQAT estimates from the proposal, EPA conducted further analysis that demonstrated seasonal differences in the $PM_{2.5}$ response to SO_2/NO_x emission reductions. EPA determined that creating 4 quarterly components to the 24-hour $PM_{2.5}$ AQAT to assess the quarterly response of downwind sulfate to upwind SO_2 reductions would be beneficial in adequately accounting for seasonal differences in the relationship between emissions and sulfate formation. Quarters were determined based on calendar year (i.e. January, February, and March were quarter 1; April, May, and June were quarter 2; July, August, and September were quarter 3; and October, November, and December were quarter 4). Each quarterly component of the 24-hour $PM_{2.5}$ AQAT was based on quarterly-specific emissions, quarterly-specific contributions from the CAMx 2012 base case state-by-state source apportionment modeling, and quarterly sulfate values from the 2012 base case and 2014 AQAT calibration scenarios. Consequently, EPA developed quarterly-specific calibration factors, and used these to estimate quarterly-specific relative response factors and resulting sulfate concentrations for each cost threshold level of SO_2 emissions (these steps are described later in this TSD).

The AQAT calibration scenario played a key role in calibrating AQAT for use in the final Transport Rule. The intent of this scenario was to create a calibration point within the range of all emission reductions examined by EPA using AQAT. This calibration point was used to create site-specific calibration factors so that the response of sulfate concentrations to upwind SO_2 emission changes would more-closely align with sulfate estimates from CAMx. To fill this role, EPA used the results of IPM modeling of a control scenario[6] with similar level and geographic distribution to the preferred remedy from the proposed Transport Rule. Selection of

[9] As described in section C.2.(c).5 of this TSD, 8 days were simulated in each quarter, for a total of 32 days per year. 32 days were mapped to each year over the 2003-2007 time frame and projected to the 2012 or 2014 year.
[10] Details on procedures for calculating average and maximum design values can be found in the Air Quality Modeling Final Rule Technical Support Document.

this AQAT calibration scenario was not an indication of the level of SO_2 reduction that would be achieved by the final Transport Rule. This scenario only served to develop the calibration points for AQAT which allowed EPA to reasonably assess the downwind impacts of SO_2 reductions both more and less stringent than the AQAT calibration scenario.

In order to facilitate understanding of the calibration process, EPA is including an example monitor for evaluation in this text: monitor number 261630033 in Wayne County, Michigan, with a 2012 base case predicted 24-hour $PM_{2.5}$ average design value of 39.48 $\mu g/m^3$ and maximum design value of 39.82 $\mu g/m^3$. Additional details for all monitors can be found in the referenced tables in the docket.

<u>(1) Create uncalibrated annual and 24-hour PM2.5 versions of AQAT for calibration</u>

To create the annual and the 24-hour $PM_{2.5}$ versions of AQAT for calibration, EPA used emissions and contributions to estimate the change in predicted sulfate due to SO_2 emission reductions under the AQAT calibration scenario relative to the 2012 base case. These "uncalibrated" versions of AQAT are directly comparable to those from the proposed Transport Rule (with the exception that for the final rule the 24-hour PM2.5 AQAT is constructed using quarterly components rather than annual).

First, EPA calculated annual and quarterly state-level 2012 base case total SO_2 emissions from all source sectors. These emissions estimates were used for the CAMx 2012 source apportionment modeling. This emissions data is divided into multiple source sectors for the purposes of air quality modeling: power sector point (from IPM), non-power sector point, non-point, onroad, nonroad, C3 marine, alm, and fires (see the Emissions Inventory Final Rule TSD for additional details on the emissions inventories used in the CAMx air quality modeling). The state-level total SO_2 emissions are the sum of emissions from all these source sectors. Next, EPA calculated the annual and quarterly state-level 2014 total SO_2 emissions across all source sectors for the AQAT calibration scenario. EPA calculated the ratio of 2014 total SO_2 emissions for the AQAT calibration scenario to 2012 total SO_2 emissions for the 2012 base case for each state modeled in CAMx. This was done on an annual basis for the annual $PM_{2.5}$ version of AQAT and on a quarterly basis for the 24-hour $PM_{2.5}$ version of AQAT. More information on the emissions inventories can be found in preamble section IV.C. The total emissions data and resulting ratios for quarter 2 of the 24-hour $PM_{2.5}$ version of AQAT can be found in Table C-1.

For each monitor, the uncalibrated annual and quarterly 2014 contribution of sulfate from each state for the AQAT calibration scenario is calculated by subtracting the estimated "uncalibrated" change in concentration from the 2012 base case contribution. The "uncalibrated" change in concentration is found by multiplying the 2012 base case sulfate contribution by the difference in the ratio of emissions. The difference in the ratio of emissions is calculated as 1 minus the ratio of total SO_2 emissions in the AQAT calibration scenario to the 2012 base case scenario. When the change in concentration is subtracted from the base case contribution, the net result is the uncalibrated estimated sulfate contribution from each state for the AQAT calibration scenario.

For each monitor, these state-level contributions are then summed to estimate total sulfate contribution from the states in the CAMx modeling domain. Finally, "other" modeled sulfate contributions ("BIOG", "OTHER", "ICBC", and "SOA") are added to the annual and quarterly total to account for sources of sulfate outside the CAMx modeling domain. The total sulfate from all the states and "other" contributions represents the total sulfate component of $PM_{2.5}$

estimated by uncalibrated AQAT for the AQAT calibration scenario. It is the ratio of the CAMx to AQAT sulfate components for this AQAT calibration scenario that becomes the constant calibration factor used in “calibrated” AQAT.

Table C-1. 2012 Base Case and 2014 AQAT Calibration Scenario Ammonium Sulfate Contributions for Monitor Number 261630033 inWayne County, Michigan, as well as Total SO_2 Emissions from all Source-Sectors for Each State.

State/Source	2012 Base Case Quarter 2 Sulfate Contributions ($\mu g/m^3$)	2012 Base Case Quarter 2 SO_2 Emissions (tons)	2014 AQAT calibration Scenario Quarter 2 SO_2 Emissions (tons)	Ratio of 2014 AQAT calibration Scenario Emissions to 2012 Base Case SO_2 Emissions for Quarter 2	Estimated 2014 Contribution of Sulfate in Quarter 2 (uncalibrated AQAT) ($\mu g/m^3$)
AL	0.50	133,175	84,803	0.64	0.32
AR	0.14	30,280	34,229	1.13	0.16
CT	0.00	4,599	4,628	1.01	0.00
DE	0.01	2,440	2,145	0.88	0.01
DC	0.00	499	485	0.97	0.00
FL	0.06	60,947	63,051	1.03	0.06
GA	0.21	128,332	46,991	0.37	0.08
IL	1.21	141,050	58,995	0.42	0.51
IN	3.09	223,451	77,561	0.35	1.07
IA	0.12	48,675	34,918	0.72	0.08
KS	0.06	26,869	24,901	0.93	0.05
KY	1.89	135,520	42,304	0.31	0.59
LA	0.23	59,724	58,568	0.98	0.22
ME	0.00	5,967	4,744	0.79	0.00
MD	0.11	29,347	25,558	0.87	0.10
MA	0.01	10,663	10,850	1.02	0.01
MI	3.93	85,280	60,550	0.71	2.79
MN	0.03	26,684	22,243	0.83	0.03
MS	0.06	15,408	15,954	1.04	0.06
MO	0.86	114,219	71,433	0.63	0.54
NE	0.02	19,586	18,871	0.96	0.02
NH	0.00	2,747	3,482	1.27	0.00
NJ	0.02	11,115	7,292	0.66	0.01
NY	0.12	51,969	33,122	0.64	0.08
NC	0.14	55,881	34,548	0.62	0.09
ND	0.03	28,083	28,235	1.01	0.03
OH	3.56	237,608	66,535	0.28	1.00
OK	0.08	39,479	38,672	0.98	0.08
PA	0.80	149,123	57,087	0.38	0.30
RI	0.00	1,316	1,315	1.00	0.00
SC	0.03	58,121	36,711	0.63	0.02
SD	0.01	9,341	9,282	0.99	0.01
TN	0.73	100,713	38,227	0.38	0.28
TX	0.18	174,356	184,266	1.06	0.19
VT	0.00	1,469	1,473	1.00	0.00
VA	0.15	42,859	31,049	0.72	0.11
WV	1.02	140,798	29,254	0.21	0.21
WI	0.09	49,290	28,540	0.58	0.05
BIOG	0.00			1	0.00
OTHER	0.91			1	0.91
ICBC	1.14			1	1.14
SOA	0.00			1	0.00
Total Sulfate Component of $PM_{2.5}$ in Quarter 2	21.54				11.21

(2) Calibrate annual and quarterly sulfate response in the annual and 24-hour $PM_{2.5}$ versions of AQAT using CAMx modeling of 2012 base and 2014 AQAT calibration scenario

Next, the estimate of the monitor specific sulfate responses under the AQAT calibration scenario was used to calibrate the the annual and 24-hour versions of AQAT to CAMx. First, the annual and quarterly changes in sulfate predicted by AQAT and CAMx relative to 2012 base case concentrations were calculated for each monitor. To calculate this for AQAT and CAMx independently, EPA subtracted the 2014 total sulfate estimated by either AQAT or CAMx for the AQAT calibration scenario from the respective 2012 total sulfate predicted by CAMx for the 2012 base case. This difference was then divided by the 2012 total sulfate predicted by CAMx for the 2012 base case (see Table C-2 for an example calculation). The calculation of these monitor-specific calibration factors provided EPA with the ability to align the sulfate response predicted by AQAT to the sulfate response predicted by CAMx at a level of SO_2 reductions that EPA expected to be within the range of all emission reductions examined by EPA.

For 24-hour $PM_{2.5}$, the CAMx estimates of the 2012 base case and 2014 AQAT calibration scenario are presented by year as well as by quarter. Thus, in the CAMx estimates, for each quarter, there are five values (one for each year from 2003-2007 projected to the future year). In contrast, the estimates from AQAT are the average of the five yearly values, since the AQAT values are derived from the "average" quarterly contributions. The AQAT and CAMX ammonium sulfate factors for 24-hour $PM_{2.5}$ can be found in the "Daily PM Calibration Factors.xlsx" excel workbook on worksheet "AQModeling Calib Factor DailyPM" in columns BA and AJ, respectively. The calibration factor is the ratio of the CAMx response factor divided by the uncalibrated AQAT response factor. This calibration factor can be found in column BC of the aforementioned excel worksheet. There is one calibration factor for each quarter, for each monitoring site.

For annual $PM_{2.5}$, the CAMx estimates used in AQAT construction are represented as 5-year averages. The AQAT and CAMx ammonium sulfate factors for annual $PM_{2.5}$ can be found in the "Annual PM Calib Factors.xlsx" excel workbook on worksheet "AQModeling Calib Factors Ann PM" in columns AI and AE, respectively. The calibration factor is the ratio of the CAMx response factor divided by the uncalibrated AQAT response factor. This calibration factor can be found in column AK of the aforementioned excel worksheet. There is a single calibration factor, representing an annual value, for each monitoring site.

Generally, for similar emission reductions, the sulfate reductions predicted by CAMx for the "warm" seasons (i.e., 2nd and 3rd calendar quarters) were greater than during the "cool" seasons (i.e., 1st and 4th quarters). Consequently, the calibration factors for the "warm" seasons are larger than they are for the "cool" seasons.

Table C-2. Total Estimated Sulfate Contributions in the 2012 Base Case and 2014 AQAT Calibration Scenario from CAMx and Uncalibrated AQAT for Monitor Number 261630033 in Wayne County, Michigan (See Table C-1) for 24-hour $PM_{2.5}$. These Values are then Used to Create a Calibration Factor.

	2012 Base Case Quarter 2 Sulfate Concentration ($\mu g/m^3$)	**Estimated 2014 Concentration of Sulfate in Quarter 2 (uncalibrated AQAT) ($\mu g/m^3$)**	**Estimated Quarter 2 Reduction Divided by 2012 Base Case Concentration**
CAMx*	22.67	13.21	0.4172
AQAT*	21.54	11.21	0.4795
Calibration Factor - Response Factor From CAMx Divided By Response Factor From AQAT			0.8700

* As described above in this section, in CAMx, there are estimated 5 values per quarter (one for each projected year, 2003-2007). In AQAT, there is just have a single "average" value per quarter. The CAMx value shown is the projected 2003 quarter 2 value.

<u>(3) Create calibrated versions of annual and 24-hour AQAT for cost threshold analysis</u>

Next, EPA created the calibrated versions of annual and 24-hour $PM_{2.5}$ AQAT for the cost threshold analysis. EPA used emissions, air quality sulfate contribution factors, and calibration factors to estimate the change in predicted sulfate due to SO_2 emission reductions under each cost threshold evaluated. First, as described in step 2, EPA calculated annual and quarterly state-level 2012 base case total SO_2 emissions, for the annual and 24-hour $PM_{2.5}$ versions of AQAT, respectively. Next, EPA calculated the annual and quarterly state-level 2014 total SO_2 emissions across all source sectors for the cost thresholds. This total is the sum of IPM predicted SO_2 emissions from power sector point sources in 2014 and the predictions of 2014 base case SO_2 emissions from all other source sectors. Note, IPM estimates of SO_2 emissions are available annually only. In order to approximate the quarterly emissions needed for the quarterly components of the 24-hour version of AQAT, EPA multiplied the annual emissions at each cost threshold for each state by the ratio of the state's quarterly to annual emissions for the power sector from SMOKE modeling of the AQAT calibration scenario. For example, the ratio for quarter one is the sum of the EGU SO_2 emissions for January, February, and March divided by the total annual EGU SO_2 emissions. Finally, EPA calculated the ratio of 2014 total SO_2 emissions for each cost threshold to 2012 total SO_2 emissions for the 2012 base case for each state modeled in CAMx. More information on the emissions inventories can be found in preamble section IV.C. This emissions data and resulting ratios for the second quarter for 24-hour $PM_{2.5}$ under the AQAT calibration scenario can also be found in Table C-1.

For each cost threshold level analyzed, on a receptor-by-receptor basis, the emissions reductions for each upwind state are associated with one of two cost threshold levels (either the base case emissions level or the particular threshold cost level being analyzed) depending on whether the upwind state is “linked” to that receptor or if the receptor is located within the state. States that are contributing above the respective air quality threshold[11] (i.e., greater than or equal to 1 percent contribution of total sulfate and nitrate for the annual and 24-hour $PM_{2.5}$) to the monitor, as well as the state containing the monitor, make SO_2 emissions reductions available at the particular threshold level. The emissions for all other states are at the base case level.

For each monitor, the predicted 2014 contribution of sulfate from each state is calculated by multiplying the state specific 2012 base case sulfate contribution by the change in ratio of total SO_2 emissions (either the cost threshold level or the base case level depending on whether the state is linked). For each receptor, the total change in sulfate, calculated by adding up the change in contributions from all states, is multiplied by the calibration factor. This calibrated change in sulfate is then subtracted from the total sulfate from the 2012 base case modeling, resulting in the “calibrated” average total sulfate. The 2012 base case sulfate includes the contributions from all upwind states as well as the “other” sulfate contributions. When this “calibrated” sulfate is combined with the other components of $PM_{2.5}$, it is possible to estimate total $PM_{2.5}$. The process of estimating design values is described in the next two sections (4 and 5) for annual $PM_{2.5}$ and for 24-hour $PM_{2.5}$, respectively.

(4) Calculate new annual $PM_{2.5}$ design values using the annual PM2.5 version of AQAT

After estimating total sulfate in 2014 for each cost threshold, EPA estimated average and maximum design values for annual $PM_{2.5}$ by adding the total sulfate to the non-sulfate components of $PM_{2.5}$ from the CAMx modeling of the 2014 AQAT calibration scenario. The non-sulfate components added in this step were ammonium nitrate, elemental carbon, organic carbon, salt, and blank mass. The resulting sum is the estimated average design value. To estimate the maximum design value, EPA took the difference between the average and maximum design value for the 2012 base case, and added this difference to the 2014 average design value.

(5) Calculating new 24-hour $PM_{2.5}$ design values using quarterly relative response factors in the 24-hour version of AQAT

- Calculate quarterly relative response factors as the ratio of calibrated AQAT predicted total sulfate to 2012 CAMx modeled total sulfate
- Calculate predicted 2014 total sulfate for all available CAMx modeled days (8 days per quarter per year) by multiplying the 2012 CAMx modeled concentrations by the quarterly relative response factors
- Add 2014 total nitrate and other $PM_{2.5}$ species from the 2014 CAMx modeling of the AQAT calibration scenario for each corresponding day
- Calculate the 98th percentile day for each modeled year
- Check the completeness and validity of each modeled year, keeping only the years with monitoring data that met completeness criteria
- Calculate average 2014 predicted DVs for each quantifiable 3-year period of projected historic monitoring data (2003-2005, 2004-2006, and 2005-2007)

[11] For the 24-hour version of AQAT, the assessment of the 1% contributions to the threshold are based on the contributions to the average design value from the 2012 base case, and not on the average quarterly contributions.

- Calculate final average DV as the average of quantifiable 2014 predicted 3-year DVs
- Calculate the maximum DV as the maximum of quantifiable 2014 predicted 3-year DVs

The estimation of design values for the 24-hour $PM_{2.5}$ standard is more complicated than it is for the annual $PM_{2.5}$ standard, because only the 98^{th} percentile day from each of the five years contributes to the design value (and the particular day selected as the 98^{th} percentile day can change at different cost threshold levels). After estimating average total sulfate in 2014 for each cost threshold for each quarter, EPA developed relative response factors (RRF) for quarterly sulfate concentrations and used these factors to calculate expected future sulfate concentrations for 32 selected modeled days for each of the 5-years accounted for in the 2012 CAMx base case modeling (2003-2007). In other words, the "average" quarterly responses were "mapped" to the 8 individual days in each quarter (32 days total per year) for each of the 5 years using the relative response factors. This was done by multiplying the appropriate quarterly RRF by the 2012 base case sulfate value for each day.

For each monitor, to calculate the quarterly relative response factors, EPA took the "average" calibrated quarterly sulfate contribution for the cost threshold level and divided it by the 2012 base case "average" quarterly sulfate contribution. For each monitor, there is a single RRF for each quarter, with the same RRF applied equally to all 5 years.

For each cost threshold level evaluated, EPA multiplied the appropriate quarterly RRF for that threshold to the 2012 base case sulfate values for each of the 32 days, for each of the 5 years, to estimate adjusted sulfate values. To these adjusted sulfate values, EPA added the concentrations from the other[12] $PM_{2.5}$ components from the 2014 AQAT calibration scenario (i.e., nitrate, elemental carbon, organic carbon, salt, and blank mass). The result is 32 $PM_{2.5}$ concentrations for each of the 5 years of analysis. The total concentration estimates (and adjusted sulfate values) for each monitor, year, and day can be found in the "dailyPM_all_years_all_quarters….xlsx " workbooks.

Next, we ranked the values for each year and selected the 98^{th} percentile for each year for use in estimation of the 3-year design values. The particular rank of the value selected depended on the sampling frequency of the monitor (for more details see section V.C.2.b (2) of the preamble, the Air Quality Modeling Final Rule TSD, and the modeling guidance document for state attainment demonstrations of the 24-hour $PM_{2.5}$). The rank of the value that is the 98^{th} percentile can be found in the "98thpercentilerank" worksheet in the "dailyPM_allyears_high_quarters.xlsx" workbook in column G.

For each monitor, the 98^{th} percentile value for each cost threshold level and for each year can be found in the appropriate worksheet and columns I through M in the "dailyPM_allyears_high_quarters.xlsx" workbook. Three valid consecutive yearly 98^{th} percentile values are needed to construct a design value. The completion codes for each potential design value 3-year time-period have values of 1, 2, 3, 4 or missing (0) for each design value

[12] By using nitrate from the AQAT calibration scenario, the estimate of nitrate is impacted by NOx reductions and SO_2 reductions which lead to nitrate replacement. The concentrations of elemental carbon, organic carbon, salt, and blank are nearly identical in the 2014 base case and AQAT calibration case CAMx modeling. The largest difference in concentration between the two modeled scenarios was 0.02 $\mu g/m^3$ for organic carbon. By using these components of $PM_{2.5}$ as modeled in the 2014 AQAT calibration scenario, EPA is appropriately accounting for any changes in these components due to Transport Rule implementation.

period. Values of 1 or 2 indicate compete data and values of 3 or 4 indicate incomplete data. Missing values, or values equal to 0, were treated as incomplete periods.

The average design value was calculated as the average of all valid design values, while the maximum design value was calculated as the maximum available valid design value.

As the cost threshold value increased, the estimated average and maximum design values at each receptor decreased. In AQAT, the estimated value of the average design value was used to estimate whether the location will be out of attainment, while the estimated maximum design value was used to estimate whether the location will be out of maintenance. The two air quality levels used were 15.05 $\mu g/m^3$ and 35.5 $\mu g/m^3$ to represent the 1997 and 2006 fine particulate matter ($PM_{2.5}$) NAAQS, respectively.

3. Description of the results of the analysis using AQAT for the final approach.

This section describes the results of the cost threshold analysis using the annual and 24-hour versions of AQAT for the annual $PM_{2.5}$, and 24-hour $PM_{2.5}$NAAQS standards. In section C.2 of this TSD, we described the construction of the annual and 24-hour versions of AQAT to estimate the air quality impacts of various levels of EGU SO_2 emissions.

For annual $PM_{2.5}$ in 2014, the average and maximum $PM_{2.5}$ design values ($\mu g/m^3$) estimated using AQAT for each identified receptor for each cost threshold level can be found in Table C-3 and C-4, respectively. The monitors are in order of decreasing 2012 base case maximum annual $PM_{2.5}$ design value. No monitors are estimated to have remaining nonattainment problems at the $2,300/ton SO_2 cost threshold. The only monitor that is estimated to have a remaining maintenance problem at the $2,300/ton SO_2 cost threshold is monitor number 420030064, located in Allegheny County, Pennsylvania (Liberty-Clairton nonattainment area). As indicated in section VIII.B of the preamble, final air quality modeling of the Transport Rule remedy scenario using CAMx indicates that the maintenance problem estimated by AQAT is resolved.

For 24-hour $PM_{2.5}$ in 2014, the estimated average and maximum air quality design values ($\mu g/m^3$) estimated using AQAT for each identified receptor for each cost threshold level can be found in Table C-5 and C-6, respectively. The monitors are in order of decreasing 2012 base case maximum 24-hour $PM_{2.5}$ design value. Based on applying AQAT, a majority of the 24-hour $PM_{2.5}$ receptors are estimated to have their nonattainment and maintenance problems resolved at the $500/ton cost threshold in 2014. However, a number of receptors are projected to require substantial additional SO_2 emission reductions to eliminate significant contribution to nonattainment and interference with maintenance of the standard.

The total number of estimated nonattainment and maintenance receptors as a function of SO_2 cost threshold is summarized in Table VI.C-2 of the preamble and can be assessed using Tables C-3, C-4, C-5, and C-6. At each cost threshold, receptors are counted if their estimated design value is greater than the NAAQS. Note that because the maximum design value (maintenance) is always equal to or greater than the average design value (nonattainment), all receptors that are estimated to have nonattainment problems are also estimated to have maintenance problems. For example, for the annual $PM_{2.5}$ standard, at a cost threshold of $500/ton, the average and maximum design values for receptor number 420030064 located in Allegheny, PA are estimated to exceed the level of the NAAQS. In Table VI.C-2 in the preamble, this monitoring site accounts for the value of 1 in both the nonattainment and nonattainment or maintenance categories for the annual $PM_{2.5}$ columns (see appendix D for a description about how the monitors were associated with nonattainment areas to create this table in the preamble).

In the assessment of air quality using the calibrated AQAT, it is difficult to estimate the relative contributions of particular upwind states contributing to a particular estimated design value for 24-hour $PM_{2.5}$ standard. The reason is that the design value is calculated using projections for different days, possibly from different seasons, and the rank of these days can change depending on the emissions changes from each cost threshold examined. For example, in the base case, the 98th percentile days which contribute to the design value could primarily be from "warm" seasons, which have high sulfate levels. At a higher cost threshold level, the 98th percentile day could shift to a "cool" season, which has a lower sulfate level. Consequently, this can confound the interpretation of the change in sulfate as well as change in the relative upwind contributions of particular states to design values.

Lastly, once the budgets for the final Transport Rule were established (based on the results of the multi-factor test) and IPM was used to model compliance with the final rule, it was possible to estimate air quality concentrations at each downwind receptor using AQAT for the final rule remedy scenario. Average and maximum design value estimates in 2014 for annual $PM_{2.5}$ and 24-hour $PM_{2.5}$can be found in Tables C-7 and C-8 in section C.4 of this TSD. CAMx was run for this same set of emissions and the air quality results from this run are also summarized in Tables C-7 and C-8 (see section C.4 of this TSD). Additional comparisons between AQAT and CAMx estimates are shown in section C.4 of this TSD.

Table C-3. Average Annual $PM_{2.5}$ DVs ($\mu g/m^3$) for SO_2 Cost Thresholds ($/ton) Assessed Using AQAT.

Monitor Identification Number	State	County	CAMx 2012 Base Case ($\mu g/m^3$)	AQAT 2014 Average Annual PM2.5 Design Values ($\mu g/m^3$).						
				Base Case	$500	$1,600	$2,300	$2,800	$3,300	$10,000
Avg. improvement from AQAT base case – 2012 base case receptors					1.60	1.87	2.02	2.10	2.15	2.42
420030064	Pennsylvania	Allegheny	17.94	17.53	15.78	15.28	15.03	14.97	14.91	14.70
390350038	Ohio	Cuyahoga	15.99	15.68	14.10	13.77	13.60	13.52	13.46	13.23
10730023	Alabama	Jefferson	16.15	15.60	14.33	14.38	14.31	14.31	14.38	14.06
390618001	Ohio	Hamilton	16.01	15.64	13.54	13.18	13.01	12.93	12.85	12.53
261630033	Michigan	Wayne	15.73	15.44	14.35	14.12	13.87	13.69	13.61	13.25
390350060	Ohio	Cuyahoga	15.67	15.34	13.75	13.42	13.25	13.17	13.11	12.88
390610014	Ohio	Hamilton	15.76	15.39	13.29	12.93	12.75	12.67	12.59	12.27
390610042	Ohio	Hamilton	15.40	15.07	12.97	12.61	12.44	12.36	12.28	11.98
171191007	Illinois	Madison	15.46	14.85	13.83	13.64	13.56	13.43	13.31	13.00
10732003	Alabama	Jefferson	15.16	14.68	13.55	13.58	13.52	13.51	13.57	13.29
390350045	Ohio	Cuyahoga	15.14	14.83	13.23	12.90	12.73	12.65	12.59	12.36
180970081	Indiana	Marion	14.86	14.52	12.68	12.40	12.26	12.19	12.09	11.79
131210039	Georgia	Fulton	15.07	14.29	13.35	13.24	13.20	13.18	13.17	13.05
390617001	Ohio	Hamilton	14.74	14.40	12.30	11.93	11.76	11.68	11.60	11.28
390350065	Ohio	Cuyahoga	14.67	14.38	12.79	12.45	12.28	12.20	12.14	11.91
180970083	Indiana	Marion	14.71	14.38	12.53	12.25	12.11	12.04	11.94	11.64

Table C-4. Maximum Annual $PM_{2.5}$ DVs ($\mu g/m^3$) for SO_2 Cost Thresholds ($/ton) Assessed Using AQAT.

Monitor identification number	State	County	CAMx 2012 Base Case ($\mu g/m^3$)	AQAT 2014 Maximum Annual PM2.5 Design Values ($\mu g/m^3$).						
				Base Case	$500	$1,600	$2,300	$2,800	$3,300	$10,000
Avg. improvement from AQAT base case – 2012 base case receptors					1.60	1.87	2.02	2.10	2.15	2.42
420030064	Pennsylvania	Allegheny	18.33	17.92	16.17	15.67	15.42	15.36	15.30	15.09
390350038	Ohio	Cuyahoga	16.66	16.35	14.77	14.44	14.27	14.19	14.13	13.90
10730023	Alabama	Jefferson	16.46	15.91	14.64	14.69	14.62	14.62	14.69	14.37
390618001	Ohio	Hamilton	16.33	15.96	13.86	13.50	13.33	13.25	13.17	12.85
261630033	Michigan	Wayne	16.32	16.03	14.94	14.71	14.46	14.28	14.20	13.84
390350060	Ohio	Cuyahoga	16.18	15.85	14.26	13.93	13.76	13.68	13.62	13.39
390610014	Ohio	Hamilton	15.98	15.61	13.51	13.15	12.97	12.89	12.81	12.49
390610042	Ohio	Hamilton	15.77	15.44	13.34	12.98	12.81	12.73	12.65	12.35
171191007	Illinois	Madison	15.73	15.12	14.10	13.91	13.83	13.70	13.58	13.27
10732003	Alabama	Jefferson	15.64	15.16	14.03	14.06	14.00	13.99	14.05	13.77
390350045	Ohio	Cuyahoga	15.61	15.30	13.70	13.37	13.20	13.12	13.06	12.83
180970081	Indiana	Marion	15.16	14.82	12.98	12.70	12.56	12.49	12.39	12.09
131210039	Georgia	Fulton	15.10	14.32	13.38	13.27	13.23	13.21	13.20	13.08
390617001	Ohio	Hamilton	15.10	14.76	12.66	12.29	12.12	12.04	11.96	11.64
390350065	Ohio	Cuyahoga	15.10	14.81	13.22	12.88	12.71	12.63	12.57	12.34
180970083	Indiana	Marion	15.06	14.73	12.88	12.60	12.46	12.39	12.29	11.99

Table C-5. Average 24-hour $PM_{2.5}$ DVs ($\mu g/m^3$) for SO_2 Cost Thresholds ($/ton) Assessed Using AQAT.

Monitor Identification Number	State	County	CAMx 2012 Base Case ($\mu g/m^3$)	AQAT 2014 Average 24-hour PM2.5 Design Values ($\mu g/m^3$).						
				Base Case	$500	$1,600	$2,300	$2,800	$3,300	$10,000
Avg. improvement from AQAT base case – 2012 base case receptors					4.09	4.77	5.09	5.22	5.35	5.79
Avg. improvement from AQAT base case – $500 receptors**					4.73	5.70	6.41	6.67	6.85	7.54
420030064**	Pennsylvania	Allegheny	56.71	54.34	47.57	46.36	45.54	45.37	45.23	44.73
420030093**	Pennsylvania	Allegheny	39.11	37.51	32.19	30.91	30.25	30.12	29.96	29.37
390350038**	Ohio	Cuyahoga	39.46	37.95	34.18	33.73	33.51	33.43	33.36	32.99
261630016**	Michigan	Wayne	38.99	38.50	34.42	34.15	33.93	33.77	33.70	33.36
390350060	Ohio	Cuyahoga	37.78	37.11	31.50	30.79	30.60	30.51	30.43	30.20
170311016**	Illinois	Cook	37.58	36.11	34.13	33.48	33.13	32.94	32.67	31.98
261630033**	Michigan	Wayne	39.48	39.01	36.31	35.59	35.00	34.65	34.43	33.55
180890022**	Indiana	Lake	34.94	34.04	32.79	32.47	32.38	32.29	32.16	31.86
540090011	West Virginia	Brooke	37.57	36.73	30.60	29.60	29.07	28.94	28.80	28.27
420710007**	Pennsylvania	Lancaster	35.98	35.54	35.19	35.02	34.95	34.94	34.93	34.88
390350045	Ohio	Cuyahoga	34.80	33.63	27.69	26.61	26.30	26.20	26.15	25.96
390811001	Ohio	Jefferson	34.56	33.58	27.64	26.41	25.79	25.65	25.49	24.92
261630019**	Michigan	Wayne	37.34	36.86	35.27	35.09	34.93	34.82	34.77	34.54
390350065	Ohio	Cuyahoga	34.91	33.50	27.65	26.61	26.11	25.95	25.81	25.28
170313301	Illinois	Cook	34.97	33.60	31.11	30.72	30.54	30.40	30.24	29.73
420070014	Pennsylvania	Beaver	36.21	34.84	29.28	28.10	27.59	27.48	27.36	26.95
420033007	Pennsylvania	Allegheny	32.40	30.98	26.27	25.31	24.88	24.80	24.71	24.48
010730023	Alabama	Jefferson	36.96	35.43	31.93	31.86	31.61	31.60	31.74	31.06
550790026	Wisconsin	Milwaukee	33.62	33.28	30.48	30.27	30.15	30.03	29.90	29.54
180970043	Indiana	Marion	35.76	34.67	28.64	27.55	27.16	26.98	26.64	25.83
261470005	Michigan	St Clair	36.23	35.61	33.35	33.01	32.78	32.67	32.59	32.29
550790043	Wisconsin	Milwaukee	36.21	34.98	32.49	32.07	31.85	31.70	31.53	31.24
180890026	Indiana	Lake	34.08	33.00	30.91	30.65	30.52	30.42	30.30	30.07
180970081	Indiana	Marion	35.85	33.70	28.44	27.66	27.35	27.21	26.93	26.19
180970066	Indiana	Marion	35.73	34.49	29.22	28.45	28.13	27.96	27.65	26.95
171191007	Illinois	Madison	36.59	34.59	29.92	29.48	29.32	29.13	28.88	28.16
550790010	Wisconsin	Milwaukee	35.47	35.03	31.50	31.05	30.82	30.73	30.62	30.32
390170003	Ohio	Butler	34.40	33.66	28.07	26.99	26.49	26.33	26.19	25.68
170316005	Illinois	Cook	34.12	33.47	32.72	32.53	32.41	32.31	32.18	31.84
420031008	Pennsylvania	Allegheny	35.04	33.41	26.95	25.44	24.69	24.51	24.33	23.69
261610008	Michigan	Washtenaw	35.05	34.93	29.40	28.71	28.54	28.47	28.42	28.18
170312001	Illinois	Cook	33.62	32.33	29.84	29.68	29.58	29.48	29.37	29.08
170310052	Illinois	Cook	34.94	33.27	30.11	29.87	29.78	29.67	29.53	29.07
421330008	Pennsylvania	York	33.38	33.11	31.60	31.21	31.03	31.00	30.96	30.83
261630015	Michigan	Wayne	35.55	34.42	32.23	31.53	31.10	30.93	30.85	30.52
010732003	Alabama	Jefferson	35.31	34.20	31.42	31.27	31.10	31.08	31.14	30.59
390618001	Ohio	Hamilton	35.29	33.57	27.63	26.51	26.11	25.96	25.77	25.40
171190023	Illinois	Madison	35.11	33.58	29.23	28.69	28.49	28.26	28.07	27.54
420031301	Pennsylvania	Allegheny	33.95	32.45	27.16	25.87	25.21	25.06	24.91	24.30
391130032	Ohio	Montgomery	33.68	32.19	24.40	23.37	23.15	23.05	22.95	22.60
420030116	Pennsylvania	Allegheny	35.59	33.88	27.97	26.86	26.34	26.23	26.08	25.57

** Identify receptors that have maximum design values greater than or equal to 35.5 $\mu g/m^3$ at the $500 cost threshold in 2014.

Table C-6. Maximum 24-hour $PM_{2.5}$ DVs ($\mu g/m^3$) for SO_2 Cost Thresholds ($/ton) Assessed Using AQAT.

Monitor Identification Number	State	County	CAMx 2012 Base Case ($\mu g/m^3$)	AQAT 2014 Maximum 24-hour PM2.5 Design Values ($\mu g/m^3$).						
				Base Case	$500	$1,600	$2,300	$2,800	$3,300	$10,000
Avg. improvement from AQAT base case – 2012 base case receptors*					4.28	4.98	5.33	5.46	5.60	6.07
Avg. improvement from AQAT base case – $500 receptors**					3.27	3.86	4.22	4.37	4.50	4.96
420030064**	Pennsylvania	Allegheny	59.93	57.64	50.72	49.46	48.63	48.49	48.35	47.82
420030093**	Pennsylvania	Allegheny	44.40	42.63	36.85	35.50	34.80	34.66	34.49	33.85
390350038**	Ohio	Cuyahoga	41.84	40.37	35.93	35.58	35.41	35.33	35.29	34.93
261630016**	Michigan	Wayne	41.28	40.77	36.20	35.88	35.65	35.49	35.42	35.10
390350060	Ohio	Cuyahoga	40.85	39.90	33.69	33.23	33.04	32.94	32.86	32.61
170311016**	Illinois	Cook	40.44	39.05	37.40	36.85	36.54	36.35	36.10	35.50
261630033**	Michigan	Wayne	39.81	39.47	36.59	35.84	35.23	34.87	34.65	33.75
180890022**	Indiana	Lake	39.58	38.68	37.00	36.63	36.51	36.35	36.11	35.57
540090011	West Virginia	Brooke	38.39	37.68	32.23	30.79	30.02	29.84	29.64	28.89
420710007**	Pennsylvania	Lancaster	38.37	37.82	37.43	37.25	37.18	37.17	37.15	37.10
390350045	Ohio	Cuyahoga	38.13	36.65	29.48	28.11	27.60	27.43	27.35	27.14
390811001	Ohio	Jefferson	37.88	36.91	30.27	28.78	28.03	27.86	27.67	26.96
261630019**	Michigan	Wayne	37.83	37.29	36.20	36.01	35.83	35.72	35.66	35.43
390350065	Ohio	Cuyahoga	37.67	36.41	28.79	27.60	27.00	26.80	26.64	26.08
170313301	Illinois	Cook	37.67	36.26	33.36	33.01	32.84	32.71	32.55	32.14
420070014	Pennsylvania	Beaver	37.42	35.99	30.46	29.27	28.70	28.58	28.46	28.04
420033007	Pennsylvania	Allegheny	37.40	35.85	30.73	29.47	28.81	28.68	28.54	28.17
010730023	Alabama	Jefferson	37.33	35.80	32.50	32.42	32.12	32.10	32.28	31.52
550790026	Wisconsin	Milwaukee	37.24	36.72	33.54	33.32	33.21	33.09	32.96	32.61
180970043	Indiana	Marion	37.20	36.09	29.00	28.09	27.82	27.70	27.46	26.83
261470005	Michigan	St Clair	37.14	36.57	34.16	33.59	33.38	33.29	33.24	33.02
550790043	Wisconsin	Milwaukee	37.10	35.89	34.22	34.03	33.92	33.83	33.73	33.46
180890026	Indiana	Lake	37.06	36.05	33.67	33.48	33.37	33.28	33.18	32.93
180970081	Indiana	Marion	36.96	34.81	28.83	27.95	27.59	27.41	27.08	26.33
180970066	Indiana	Marion	36.92	35.62	30.40	29.52	29.13	28.93	28.54	27.69
171191007	Illinois	Madison	36.83	35.20	31.19	30.85	30.66	30.42	30.10	29.18
550790010	Wisconsin	Milwaukee	36.71	36.56	33.47	33.25	33.13	33.04	32.94	32.66
390170003	Ohio	Butler	36.59	36.03	28.71	27.76	27.33	27.17	27.01	26.53
170316005	Illinois	Cook	36.42	35.87	35.09	34.90	34.82	34.71	34.59	34.23
420031008	Pennsylvania	Allegheny	36.35	34.65	28.15	26.48	25.62	25.39	25.15	24.29
261610008	Michigan	Washtenaw	36.32	35.38	30.20	29.50	29.33	29.25	29.20	28.95
170312001	Illinois	Cook	36.12	34.95	32.71	32.49	32.33	32.22	32.07	31.71
170310052	Illinois	Cook	36.07	34.06	30.62	30.41	30.31	30.21	30.08	29.74
421330008	Pennsylvania	York	36.06	35.89	34.55	34.12	33.91	33.88	33.84	33.69
261630015	Michigan	Wayne	36.00	34.81	33.04	32.35	31.99	31.82	31.74	31.39
010732003	Alabama	Jefferson	35.94	34.95	32.23	32.08	31.91	31.89	31.94	31.43
390618001	Ohio	Hamilton	35.85	34.01	28.23	27.13	26.73	26.59	26.45	26.03
171190023	Illinois	Madison	35.81	34.53	30.23	29.70	29.50	29.26	29.07	28.52
420031301	Pennsylvania	Allegheny	35.65	33.91	28.05	26.67	26.15	26.04	25.92	25.45
391130032	Ohio	Montgomery	35.61	33.81	25.99	24.94	24.62	24.48	24.31	23.79
420030116	Pennsylvania	Allegheny	35.59	33.88	27.97	26.86	26.34	26.23	26.08	25.57

* Used in Table VI.C-1 of the preamble

** Used in Table VI.D-1 of the preamble, Identify receptors that have maximum design values greater than or equal to 35.5 $\mu g/m^3$ at the $500 cost threshold in 2014.

4. Comparison between the air quality assessment tool estimates and CAMx air quality modeling estimates.

As the AQAT was being developed for the final Transport Rule, it was possible to evaluate the estimates from the tool with the model predictions from CAMx for the 2014 base case scenario. This case was independently modeled in CAMx. The estimates were not used in the development or calibration of the AQAT. Consequently, a comparative analysis was done between the assessment tool and the CAMx modeling for 2014 base case sulfate estimates as well as the resulting design value estimates. Additionally, when the CAMx air quality modeling of the final remedy (2014 control case) was available, a corresponding comparative analysis was also done with the estimates from the assessment tool.

Examination of the comparison for the 2014 base shows strong correlations (nearly one to one) between the estimated design values from AQAT and CAMx (Table C-10 and Figure C-1)

Examination of the results of the CAMx modeling for 2014, implementing the remedy, shows that nearly all of the air quality monitoring locations of interest are estimated to be brought into attainment and maintenance for both the 24-hour and annual $PM_{2.5}$ standards (see sections VI.C and VI.D of the preamble). Qualitatively, these results are quite similar to those from the assessment tool. Quantitatively, the results are also very similar, demonstrating that the calibrated AQAT was adequate for the intended purpose (Tables C-7 and C-8, Figures C-1 and C-2).

In addition, for the 24-hour $PM_{2.5}$ standards, EPA conducted a detailed comparison of the sulfate estimates from AQAT and CAMx (relative to the 98th percentile days selected according to CAMx) for both the 2014 base case and 2014 remedy case. The comparison is shown graphically for sulfate in Figure C-3. The sulfate estimates, as well as the $PM_{2.5}$ concentrations for the CAMx 98th percentile days, are contained in Appendix B, Tables B-1 and B-2. Appendix E shows updated estimates for the final Transport Rule remedy in comparison with Final Remedy Sensitivity (where the variability limits were increased).

Table C-7. Average and Maximum Annual $PM_{2.5}$ DVs ($\mu g/m^3$) in the 2014 Remedy Case Scenarios as Modeled in CAMx and as Estimated in Calibrated AQAT, for Receptors with Maximum DVs Greater than or Equal to 15.05 $\mu g/m^3$ in the 2012 Base Case.

Monitor Identification Number	**State**	**County**	**2014 Remedy Scenario**					
			CAMx Avg. DV	**CAMx Max. DV**	**AQAT Avg. DV**	**AQAT Max. DV**	**Difference, Avg. DV (CAMx-AQAT)**	**Difference, Max. DV (CAMx-AQAT)**
Avg. of all 2012 base case			12.74	13.05	12.98	13.36	-0.24	-0.30
420030064	Pennsylvania	Allegheny	14.62	14.95	14.86	15.25	-0.24	-0.30
390350038	Ohio	Cuyahoga	12.99	13.54	13.51	14.18	-0.52	-0.64
010730023	Alabama	Jefferson	13.94	14.21	13.89	14.20	0.05	0.01
390618001	Ohio	Hamilton	12.73	12.99	12.96	13.28	-0.23	-0.29
261630033	Michigan	Wayne	13.59	14.08	13.77	14.36	-0.18	-0.28
390350060	Ohio	Cuyahoga	12.70	13.14	13.16	13.67	-0.46	-0.53
390610014	Ohio	Hamilton	12.47	12.63	12.70	12.92	-0.23	-0.29
390610042	Ohio	Hamilton	12.16	12.47	12.36	12.73	-0.20	-0.26
171191007	Illinois	Madison	13.28	13.51	13.39	13.66	-0.11	-0.15
010732003	Alabama	Jefferson	13.11	13.53	13.13	13.61	-0.02	-0.08
390350045	Ohio	Cuyahoga	12.15	12.53	12.64	13.11	-0.49	-0.58
180970081	Indiana	Marion	12.01	12.27	12.24	12.54	-0.23	-0.27
131210039	Georgia	Fulton	12.99	13.02	13.07	13.10	-0.08	-0.08
390617001	Ohio	Hamilton	11.48	11.80	11.71	12.07	-0.23	-0.27
390350065	Ohio	Cuyahoga	11.69	12.03	12.19	12.62	-0.50	-0.59
180970083	Indiana	Marion	11.86	12.16	12.09	12.44	-0.23	-0.28

Table C-8. Average and Maximum 24-hour $PM_{2.5}$ DVs ($\mu g/m^3$) in the 2014 Base Case and 2014 Remedy Case Scenarios as Modeled in CAMx and as Estimated in AQAT.

Monitor Identification Number	**State**	**County**	**2014 Base Case Scenario**						**2014 Remedy Scenario**					
			CAMx Avg. DV	**CAMx Max. DV**	**AQAT Avg. DV**	**AQAT Max. DV**	**Difference, Avg. DV (CAMx-AQAT)**	**Difference, Max. DV (CAMx - AQAT)**	**CAMx Avg. DV**	**CAMx Max. DV**	**AQAT Avg. DV**	**AQAT Max. DV**	**Difference, Avg. DV (CAMx - AQAT)**	**Difference, Max. DV (CAMx - AQAT)**
avg. of 6 sites*			38.89	41.49	39.23	41.88	-0.34	-0.38	35.52	38.05	35.72	38.27	-0.20	-0.22
avg. of 8 sites**			38.73	41.01	39.04	41.39	-0.32	-0.38	35.01	37.17	35.32	37.50	-0.31	-0.33
Avg. of all 2012 base case			34.79	36.70	35.05	36.96	-0.26	-0.27	29.53	31.17	29.82	31.48	-0.29	-0.31
420030064	Pennsylvania	Allegheny	54.14	57.51	54.34	57.64	-0.20	-0.14	45.03	48.09	45.45	48.52	-0.42	-0.43
420030093	Pennsylvania	Allegheny	37.53	42.57	37.51	42.63	0.03	-0.06	29.44	33.76	29.88	34.28	-0.44	-0.52
390350038	Ohio	Cuyahoga	38.24	40.57	37.95	40.37	0.29	0.21	32.64	34.55	33.46	35.39	-0.82	-0.84
261630016	Michigan	Wayne	37.94	40.17	38.50	40.77	-0.56	-0.60	33.72	35.43	33.88	35.61	-0.16	-0.18
390350060	Ohio	Cuyahoga	36.78	39.76	37.11	39.90	-0.33	-0.14	29.82	32.20	30.51	32.94	-0.69	-0.74
170311016	Illinois	Cook	35.89	38.72	36.11	39.05	-0.22	-0.33	32.69	36.16	32.95	36.40	-0.26	-0.24
261630033	Michigan	Wayne	38.22	38.52	39.01	39.47	-0.79	-0.95	34.31	34.50	34.74	34.95	-0.43	-0.45
180890022	Indiana	Lake	33.77	38.31	34.04	38.68	-0.27	-0.37	32.18	36.10	32.31	36.30	-0.13	-0.20
540090011	West Virginia	Brooke	36.20	37.04	36.73	37.68	-0.53	-0.63	28.39	29.11	28.83	29.63	-0.44	-0.52
420710007	Pennsylvania	Lancaster	35.31	37.60	35.54	37.82	-0.24	-0.22	34.77	36.97	34.87	37.08	-0.10	-0.11
390350045	Ohio	Cuyahoga	33.78	37.08	33.63	36.65	0.14	0.43	25.51	26.61	26.23	27.43	-0.72	-0.82
390811001	Ohio	Jefferson	33.16	36.45	33.58	36.91	-0.43	-0.46	25.14	27.30	25.57	27.76	-0.43	-0.46
261630019	Michigan	Wayne	36.31	36.65	36.86	37.29	-0.55	-0.64	34.71	35.57	34.87	35.74	-0.16	-0.17
390350065	Ohio	Cuyahoga	33.77	36.57	33.50	36.41	0.26	0.16	25.15	25.94	25.95	26.81	-0.80	-0.87
170313301	Illinois	Cook	33.49	36.17	33.60	36.26	-0.11	-0.09	30.23	32.58	30.35	32.70	-0.12	-0.12
420070014	Pennsylvania	Beaver	34.57	35.73	34.84	35.99	-0.27	-0.26	27.00	28.09	27.39	28.49	-0.39	-0.40
420033007	Pennsylvania	Allegheny	30.95	35.71	30.98	35.85	-0.03	-0.14	24.54	28.30	24.78	28.63	-0.24	-0.33
010730023	Alabama	Jefferson	35.69	36.01	35.43	35.80	0.26	0.21	31.14	31.63	31.10	31.57	0.04	0.06
550790026	Wisconsin	Milwaukee	32.39	35.99	33.28	36.72	-0.88	-0.73	29.96	32.95	30.08	33.10	-0.12	-0.15
180970043	Indiana	Marion	34.35	35.73	34.67	36.09	-0.32	-0.36	26.67	27.42	27.13	27.76	-0.46	-0.34
261470005	Michigan	St Clair	35.06	36.01	35.61	36.57	-0.54	-0.56	32.28	32.94	32.67	33.29	-0.39	-0.35
550790043	Wisconsin	Milwaukee	34.57	35.41	34.98	35.89	-0.41	-0.48	31.69	33.83	31.80	33.92	-0.11	-0.09
180890026	Indiana	Lake	32.82	35.82	33.00	36.05	-0.19	-0.23	30.36	33.25	30.49	33.39	-0.13	-0.14
180970081	Indiana	Marion	34.12	35.18	33.70	34.81	0.42	0.37	26.90	27.04	27.30	27.54	-0.40	-0.50
180970066	Indiana	Marion	34.21	35.34	34.49	35.62	-0.28	-0.28	27.67	28.63	28.10	29.11	-0.43	-0.48
171191007	Illinois	Madison	34.68	35.36	34.59	35.20	0.08	0.16	29.24	30.51	29.32	30.64	-0.08	-0.13
550790010	Wisconsin	Milwaukee	34.08	35.44	35.03	36.56	-0.95	-1.12	30.76	33.05	30.83	33.13	-0.07	-0.08
390170003	Ohio	Butler	33.01	35.42	33.66	36.03	-0.65	-0.61	26.17	26.97	26.47	27.29	-0.30	-0.32
170316005	Illinois	Cook	32.72	34.94	33.47	35.87	-0.75	-0.93	31.90	34.32	32.02	34.45	-0.12	-0.13
420031008	Pennsylvania	Allegheny	33.28	34.49	33.41	34.65	-0.13	-0.16	24.00	24.85	24.47	25.38	-0.47	-0.53
261610008	Michigan	Washtenaw	33.93	35.01	34.93	35.38	-1.00	-0.37	28.42	29.21	28.47	29.26	-0.05	-0.05
170312001	Illinois	Cook	32.46	34.96	32.33	34.95	0.13	0.01	29.41	32.09	29.50	32.21	-0.09	-0.12
170310052	Illinois	Cook	33.20	34.12	33.27	34.06	-0.07	0.06	29.54	30.06	29.69	30.20	-0.15	-0.14
421330008	Pennsylvania	York	32.65	35.36	33.11	35.89	-0.46	-0.53	30.81	33.68	30.92	33.79	-0.11	-0.11
261630015	Michigan	Wayne	34.20	34.69	34.42	34.81	-0.22	-0.12	30.80	31.67	31.02	31.91	-0.22	-0.24
010732003	Alabama	Jefferson	34.27	34.92	34.20	34.95	0.07	-0.03	30.59	31.39	30.62	31.46	-0.03	-0.07
390618001	Ohio	Hamilton	33.51	33.92	33.57	34.01	-0.07	-0.09	25.60	26.29	25.96	26.64	-0.36	-0.35
171190023	Illinois	Madison	32.86	33.63	33.58	34.53	-0.72	-0.90	28.33	29.33	28.41	29.41	-0.08	-0.08
420031301	Pennsylvania	Allegheny	32.38	33.87	32.45	33.91	-0.07	-0.04	24.58	25.49	24.96	25.85	-0.38	-0.36
391130032	Ohio	Montgomery	32.15	33.93	32.19	33.81	-0.04	0.12	22.85	24.24	23.09	24.54	-0.24	-0.30
420030116	Pennsylvania	Allegheny	33.87	33.87	33.88	33.88	-0.02	-0.02	25.67	25.67	26.13	26.13	-0.46	-0.46

*The six sites are Allegheny, PA (64); Lancaster, PA (07); Wayne, MI (16 and 19); Cook, IL (16); and Lake, IN (22).

**The eight sites include the six sites listed above as well as Cuyahoga, OH (38) and Wayne, MI (33).

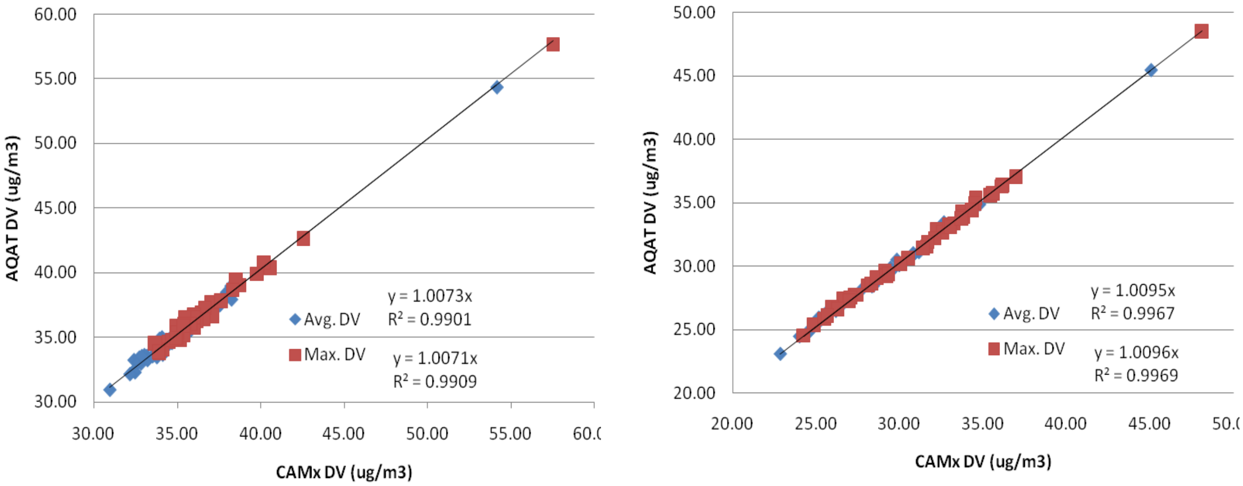


Figure C-1. Least squares linear regression plots showing correlations between estimated average and maximum design values (μg/m^3) for 24-hour $PM_{2.5}$ for CAMx and calibrated AQAT for the 2014 base case (left panel) and 2014 remedy (right panel).

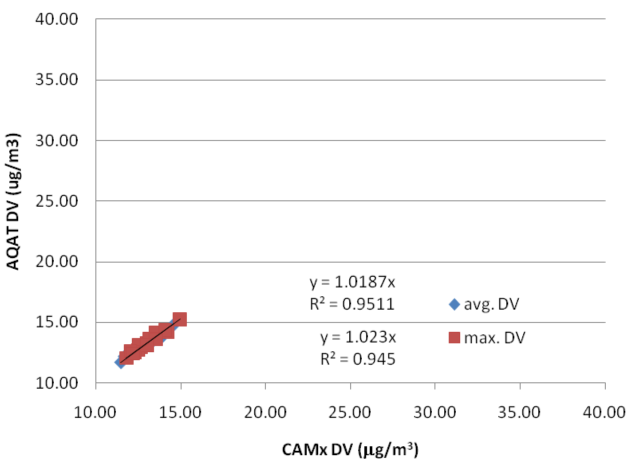
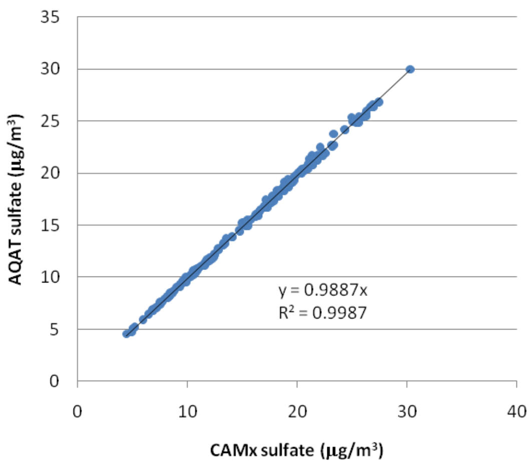
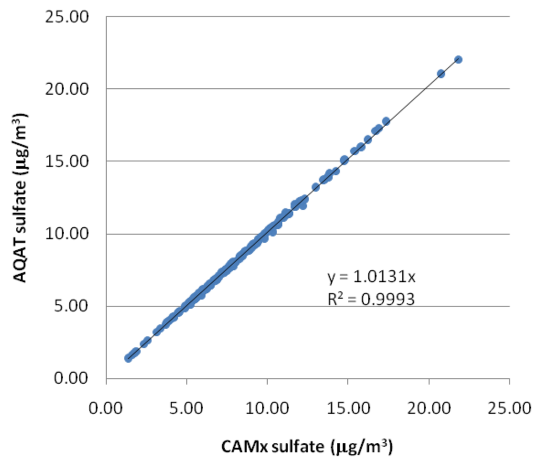


Figure C-2. Least squares linear regression plots showing correlations between estimated average and maximum design values (μg/m^3) for annual $PM_{2.5}$ for CAMx and calibrated AQAT for the 2014 remedy.





*98th percentile day chosen by CAMx, with the matching day from AQAT selected for comparison.

Figure C-3. Least squares linear regression plots showing correlations between estimated sulfate (µg/m^3) for the 98th percentile 24-hour $PM_{2.5}$ day for each year* for CAMx and calibrated AQAT for the 2014 base case (left panel) and 2014 remedy (right panel).

<u>5. Using the AQAT to estimate contributions in 2012 resulting from "leakage" of emissions to states not included in one or more of the programs for the Transport Rule</u>.

As described in sections VI.C and XII.J.2.a. of the preamble for the final Transport Rule, EPA projects that some states not covered by any of the fine particle control programs in the final Transport Rule may experience increases of SO_2 emissions greater than 5,000 tons compared to the base case. These states are Arkansas, Colorado, Louisiana, Montana, and Wyoming. Using both the annual and 24-hour versions of AQAT, for the states with source contribution modeling (i.e., Arkansas and Louisiana), EPA estimated whether these SO_2 emission increases would result in contributions from these states that are greater than or equal to the contribution thresholds. This was done by adding the "leakage" emissions to the 2012 base case emissions. As can be seen in the "base leakage_2012_threshold" worksheet in the "annual PM25 AQAT.xlsx" workbook, the estimated contributions from these states for annual $PM_{2.5}$ nonattainment and maintenance sites remain well below the 1% NAAQS threshold.

A similar assessment was made for the 24-hour $PM_{2.5}$NAAQS. EPA added the relative SO_2 emission increases to each of the quarterly emission values for the 2012 base case. EPA then used the 24-hour $PM_{2.5}$ AQAT and estimated the 2012 base case quarterly contributions and the resulting design values for all monitors. EPA, then, examined the sulfate contributions from these states, finding that Arkansas had relatively large contributions in the summer months to sites in Cook, IL (monitor 170311016 quarter 2); and in Lake, IN (monitors 180890022 and

180890026 in quarter 2). For the Cook, IL site, only one of the 98th percentile values is in the second quarter (2007). For the Lake county monitors 180890022 and 180890026, none of the 98th percentile values are in the second quarter. Consequently, EPA concludes that Arkansas' contribution is unlikely to go above the 1% contribution threshold. Similarly, Louisiana had relatively large contributions to Jefferson, AL in quarter 1. In looking at when the 98th percentile days were in the years for 2003-2007, for monitor 10730023 Jefferson, AL, the values did not occur in quarter 1. EPA concludes that LA does not exceed the 1% contribution threshold.

Appendix A: IPM Runs Used in Transport Rule Significant Contribution Analysis

Table A-1 lists IPM runs used in the significant contribution analysis. The IPM runs can be found in the docket for this rulemaking (Docket ID No. EPA-HQ-OAR-2009-0491).

Table Appendix A-1. IPM Runs Used in Transport Rule Significant Contribution Analysis

Run Name	**Run Description**
TR_Base_Case_Final	Base Case model run, which includes the national Title IV SO_2 cap-and-trade program; NO_x SIP Call regional ozone season cap-and-trade program; and settlements and state rules through Fall of 2010. This run represents conditions without the proposed Transport Rule and without the rule it would replace (CAIR).
TR_SO2_500_Final	Imposes a marginal cost of $500 per ton of NO_x year round in annual states starting in 2012, $500 per ton of ozone season NO_x in ozone states starting in 2012, $500 per ton for SO_2 year round in "Group 2" states starting in 2012, $500 per ton for Group 1 states in 2012 and 2013, $500 per ton for Group 1 states in 2014 and each year thereafter. Also forces all SCR and FGD to operate for relevant time period if in a TR covered state.
TR_SO2_1600_Final	Imposes a marginal cost of $500 per ton of NO_x year round in annual states starting in 2012, $500 per ton of ozone season NO_x in ozone states starting in 2012, $500 per ton for SO_2 year round in "Group 2" states starting in 2012, $500 per ton for Group 1 states in 2012 and 2013, $1,600 per ton for Group 1 states in 2014 and each year thereafter. Also forces all SCR and FGD to operate for relevant time period if in a TR covered state.
TR_SO2_2300_Final	Imposes a marginal cost of $500 per ton of NO_x year round in annual states starting in 2012, $500 per ton of ozone season NO_x in ozone states starting in 2012, $500 per ton for SO_2 year round in "Group 2" states starting in 2012, $500 per ton for Group 1 states in 2012 and 2013, $2,300 per ton for Group 1 states in 2014 and each year thereafter. Also forces all SCR and FGD to operate for relevant time period if in a TR covered state.
TR_SO2_2800_Final	Imposes a marginal cost of $500 per ton of NO_x year round in annual states starting in 2012, $500 per ton of ozone season NO_x in ozone states starting in 2012, $500 per ton for SO_2 year round in "Group 2" states starting in 2012, $500 per ton for Group 1 states in 2012 and 2013, $2,800 per ton for Group 1 states in 2014 and each year thereafter. Also forces all SCR and FGD to operate for relevant time period if in a TR covered state.

TR_SO2_3300_Final	Imposes a marginal cost of $500 per ton of NO_x year round in annual states starting in 2012, $500 per ton of ozone season NO_x in ozone states starting in 2012, $500 per ton for SO_2 year round in "Group 2" states starting in 2012, $500 per ton for Group 1 states in 2012 and 2013, $3,300 per ton for Group 1 states in 2014 and each year thereafter. Also forces all SCR and FGD to operate for relevant time period if in a TR covered state.
TR_SO2_10,000_Final	Imposes a marginal cost of $500 per ton of NO_x year round in annual states starting in 2012, $500 per ton of ozone season NO_x in ozone states starting in 2012, $500 per ton for SO_2 year round in "Group 2" states starting in 2012. For SO_2 "Group 1" states, a cap of 2.41 million tons is imposed in 2012 and 2013, and a cap of 344,000 ton is imposed in 2014 and each year thereafter for SO_2. These caps were designed to reflect a 70% reduction from levels observed in the $500 per ton for Group 1 states in 2012 and 2013, $3,300 per ton for Group 1 states in 2014 and each year thereafter. Also forces all SCR and FGD to operate for relevant time period if in a TR covered state.
TR_NOX_OS_500_Final	Imposes a marginal cost of $500 per ton of NO_x reduced in the ozone season on each of 26 ozone states (including the six states for which EPA is issuing a supplemental proposal to require ozone season NO_x reductions) starting in 2012. Also forces dispatchable SCRs to run in the ozone season if located in this region
TR_NOX_OS_1000_Final	Imposes a marginal cost of $1,000 per ton of NO_x reduced in the ozone season on each of 26 ozone states (including the six states for which EPA is issuing a supplemental proposal to require ozone season NO_x reductions) starting in 2012. Also forces dispatchable SCRs to run in the ozone season if located in this region
TR_NOX_OS_5000_Final	Imposes a marginal cost of $5,000 per ton of NO_x reduced in the ozone season on each of 26 ozone states (including the six states for which EPA is issuing a supplemental proposal to require ozone season NO_x reductions) starting in 2012. Also forces dispatchable SCRs to run in the ozone season if located in this region
TR_NOX_500_Final	Imposes a marginal cost of $500 per ton of NO_x reduced annually on each of 23 states in the annual region. Also forces SCRs to operate year round if located in this region
TR_NOX_1000_Final	Imposes a marginal cost of $1,000 per ton of NO_x reduced annually on each of 23 states in the annual region. Also forces SCRs to operate year round if located in this region
TR_NOX_2500_Final	Imposes a marginal cost of $2,500 per ton of NO_x reduced annually on each of 23 states in the annual region. Also forces SCRs to operate year round if located in this region
TR_Remedy_Final*	Models the air quality-assured trading final remedy described in the Transport Rule preamble with variability limits ranging from 10 to 20%

TR_Remedy_Sensitivity_with_final_variability_limits	Models the air quality-assured trading final remedy described in the Transport Rule preamble with variability limits of 18% for SO2 and Annual NOx, and 21% for ozone-season NOx and other technical corrections discussed in Section VIII.A of the preamble

*****These projected impacts of this final rule do not reflect minor technical corrections to SO2 budgets in three states (KY, MI, and NY). These projections also assumed preliminary variability limits that were smaller than the variabilty limits finalized in this rule. EPA conducted sensitivity analysis confirming that these differences do not meaningfully alter any of the Agency's findings or conclusions based on the projected cost, benefit, and air quality impacts presented for the final Transport Rule. The results of this sensitivity analysis are presented in Appendix F in the final Transport Rule RIA. The TR_Remedy_Sensitivity_with_final_variability_limits run below includes such corrections, and the subsequent AQAT analysis on this run suggest no difference in air quality impacts (see discussion earlier in TSD)

Appendix B: Detailed Comparison of AQAT Estimates with CAMx Results

This Appendix contains tables with detailed comparisons of the sulfate and total $PM_{2.5}$ for the AQAT estimates compared with CAMx for the 2014 base case and 2014 final remedy (Table Appendix B-1 and Table Appendix B-2, respectively). The 98th percentile days were selected based on the days used to create the design value according to the CAMx results. That is, the 98th percentile day may have been different in AQAT. For this particular analysis, whatever day the "Future Date" was selected based on the CAMx estimates was the day selected from the AQAT results. Consequently, the AQAT to CAMx design value comparison (presented in table C-10 in this TSD) could have been based on different subset of days from AQAT.

Table Appendix B-1. Comparison of Sulfate and Total $PM_{2.5}$ for 98th Percentile Days* for the 2014 Base Case.

Future Date	Monitor Identification Number	State	County	2012 Base Case Max. DV	Sulfate			Total PM2.5		
					CAMx	AQAT	Difference (CAMx-AQAT), Sulfate	CAMx	AQAT	Difference (CAMx-AQAT), Total PM2.5
20031031	420030064	Pennsylvania	Allegheny	59.93	15.15	15.22	-0.07	56.44	56.51	-0.07
20040301	420030064	Pennsylvania	Allegheny	59.93	15.32	15.11	0.21	57.78	58.91	-1.13
20050914	420030064	Pennsylvania	Allegheny	59.93	30.25	29.99	0.25	58.31	58.04	0.26
20060618	420030064	Pennsylvania	Allegheny	59.93	22.04	22.50	-0.46	47.30	47.75	-0.46
20070422	420030064	Pennsylvania	Allegheny	59.93	21.32	21.76	-0.44	45.76	46.20	-0.44
20030626	420030093	Pennsylvania	Allegheny	44.40	18.15	18.37	-0.22	47.08	47.29	-0.22
20040608	420030093	Pennsylvania	Allegheny	44.40	15.11	15.29	-0.18	39.27	39.45	-0.18
20050913	420030093	Pennsylvania	Allegheny	44.40	19.20	19.00	0.20	41.35	41.14	0.21
20060710	420030093	Pennsylvania	Allegheny	44.40	14.03	13.89	0.15	30.37	30.21	0.15
20070524	420030093	Pennsylvania	Allegheny	44.40	10.48	10.61	-0.13	27.40	27.52	-0.12
20030821	390350038	Ohio	Cuyahoga	41.84	25.34	24.82	0.52	40.83	40.31	0.52
20040607	390350038	Ohio	Cuyahoga	41.84	25.06	24.91	0.14	36.78	36.63	0.14
20050913	390350038	Ohio	Cuyahoga	41.84	27.39	26.83	0.56	44.10	43.54	0.57
20060818	390350038	Ohio	Cuyahoga	41.84	19.56	19.16	0.40	31.63	31.23	0.40
20070906	390350038	Ohio	Cuyahoga	41.84	21.18	20.75	0.43	34.21	33.78	0.44
20030318	261630016	Michigan	Wayne	41.28	11.05	10.92	0.13	41.57	42.52	-0.95
20040730	261630016	Michigan	Wayne	41.28	20.55	20.33	0.21	32.35	32.13	0.22
20040904	261630016	Michigan	Wayne	41.28	20.55	20.33	0.21	32.35	32.13	0.22
20050202	261630016	Michigan	Wayne	41.28	12.40	12.26	0.14	46.60	47.67	-1.07
20060330	261630016	Michigan	Wayne	41.28	8.80	8.70	0.10	33.21	33.97	-0.76
20070906	261630016	Michigan	Wayne	41.28	18.37	18.18	0.19	28.98	28.78	0.19
20030702	390350060	Ohio	Cuyahoga	40.85	25.89	25.36	0.53	38.69	38.16	0.53
20040218	390350060	Ohio	Cuyahoga	40.85	10.82	10.59	0.24	38.40	39.53	-1.12
20051004	390350060	Ohio	Cuyahoga	40.85	16.51	16.29	0.21	42.19	42.79	-0.61
20060529	390350060	Ohio	Cuyahoga	40.85	15.15	15.06	0.09	28.02	27.93	0.09
20070921	390350060	Ohio	Cuyahoga	40.85	21.98	21.53	0.45	32.92	32.47	0.45
20030316	170311016	Illinois	Cook	40.44	8.66	8.64	0.02	38.12	38.72	-0.60
20041229	170311016	Illinois	Cook	40.44	8.37	8.29	0.08	35.24	36.08	-0.83
20050802	170311016	Illinois	Cook	40.44	19.50	19.07	0.44	42.79	42.35	0.44
20061219	170311016	Illinois	Cook	40.44	6.44	6.38	0.06	27.24	27.88	-0.64
20070617	170311016	Illinois	Cook	40.44	12.48	12.15	0.34	31.56	31.28	0.27
20030301	261630033	Michigan	Wayne	39.81	9.69	9.58	0.11	36.63	37.44	-0.81
20040608	261630033	Michigan	Wayne	39.81	21.83	21.75	0.08	33.43	33.35	0.08
20050206	261630033	Michigan	Wayne	39.81	11.98	11.84	0.14	45.17	46.17	-1.00
20061213	261630033	Michigan	Wayne	39.81	7.50	7.59	-0.10	36.95	38.88	-1.93
20070524	261630033	Michigan	Wayne	39.81	20.26	20.19	0.07	31.06	30.99	0.07
20030301	180890022	Indiana	Lake	39.58	11.72	11.70	0.02	40.77	41.06	-0.29
20041226	180890022	Indiana	Lake	39.58	10.70	10.77	-0.08	38.80	39.69	-0.89
20050113	180890022	Indiana	Lake	39.58	10.14	10.13	0.01	35.36	35.61	-0.25
20060123	180890022	Indiana	Lake	39.58	6.97	6.96	0.01	24.45	24.62	-0.17
20070921	180890022	Indiana	Lake	39.58	17.57	17.15	0.42	30.58	30.16	0.42
20031229	540090011	West Virginia	Brooke	38.39	9.56	9.71	-0.15	36.44	36.76	-0.32
20040212	540090011	West Virginia	Brooke	38.39	16.98	16.70	0.28	39.36	40.62	-1.25
20050419	540090011	West Virginia	Brooke	38.39	24.93	25.34	-0.41	35.33	35.74	-0.41
20060222	540090011	West Virginia	Brooke	38.39	14.11	13.87	0.23	32.78	33.82	-1.04
20070828	540090011	West Virginia	Brooke	38.39	20.39	20.39	0.00	39.07	39.05	0.02
20030313	420710007	Pennsylvania	Lancaster	38.37	11.56	11.41	0.15	44.04	44.43	-0.39
20041009	420710007	Pennsylvania	Lancaster	38.37	4.43	4.52	-0.10	30.06	30.00	0.06
20050209	420710007	Pennsylvania	Lancaster	38.37	10.14	10.01	0.13	38.69	39.03	-0.34
20060330	420710007	Pennsylvania	Lancaster	38.37	8.57	8.46	0.11	32.78	33.07	-0.29
20070301	420710007	Pennsylvania	Lancaster	38.37	8.35	8.24	0.11	31.94	32.22	-0.28
20030702	390350045	Ohio	Cuyahoga	38.13	26.24	25.70	0.54	38.50	37.96	0.54
20040304	390350045	Ohio	Cuyahoga	38.13	10.89	10.65	0.24	33.29	34.43	-1.14
20050913	390350045	Ohio	Cuyahoga	38.13	26.89	26.34	0.55	39.44	38.89	0.55
20060210	390350045	Ohio	Cuyahoga	38.13	8.22	8.04	0.18	25.25	26.11	-0.86
20070921	390350045	Ohio	Cuyahoga	38.13	20.41	20.00	0.42	30.07	29.65	0.42
20031126	390811001	Ohio	Jefferson	37.88	13.51	13.72	-0.21	34.02	34.46	-0.44
20040702	390811001	Ohio	Jefferson	37.88	20.06	20.06	0.00	40.54	40.52	0.02
20050913	390811001	Ohio	Jefferson	37.88	17.19	17.19	0.00	34.81	34.79	0.02
20060827	390811001	Ohio	Jefferson	37.88	12.75	12.74	0.00	25.94	25.92	0.01
20070804	390811001	Ohio	Jefferson	37.88	13.30	13.30	0.00	27.03	27.02	0.01
20030801	261630019	Michigan	Wayne	37.83	20.28	20.05	0.23	32.86	32.62	0.24
20040304	261630019	Michigan	Wayne	37.83	7.56	7.44	0.12	29.72	30.26	-0.53
20050206	261630019	Michigan	Wayne	37.83	12.12	11.93	0.19	47.37	48.23	-0.86

20060309	261630019	Michigan	Wayne	37.83	8.35	8.22	0.13	32.80	33.39	-0.59
20070921	261630019	Michigan	Wayne	37.83	16.46	16.27	0.19	26.75	26.56	0.20
20030316	390350065	Ohio	Cuyahoga	37.67	11.97	11.71	0.26	36.18	37.43	-1.25
20040924	390350065	Ohio	Cuyahoga	37.67	22.44	21.99	0.46	32.32	31.86	0.46
20050627	390350065	Ohio	Cuyahoga	37.67	25.62	25.47	0.15	41.22	41.07	0.15
20060710	390350065	Ohio	Cuyahoga	37.67	16.38	16.05	0.34	23.73	23.39	0.34
20070921	390350065	Ohio	Cuyahoga	37.67	22.20	21.75	0.45	31.98	31.52	0.46
20030202	170313301	Illinois	Cook	37.67	7.16	7.08	0.08	32.35	32.70	-0.35
20040903	170313301	Illinois	Cook	37.67	17.86	17.35	0.51	34.82	34.30	0.51
20050203	170313301	Illinois	Cook	37.67	9.18	9.07	0.10	41.34	41.79	-0.45
20060704	170313301	Illinois	Cook	37.67	11.46	11.14	0.33	22.53	22.20	0.33
20060806	170313301	Illinois	Cook	37.67	11.46	11.14	0.33	22.53	22.20	0.33
20071120	170313301	Illinois	Cook	37.67	7.36	7.32	0.05	30.35	31.31	-0.96
20030822	420070014	Pennsylvania	Beaver	37.42	15.45	15.51	-0.06	27.44	27.49	-0.05
20040711	420070014	Pennsylvania	Beaver	37.42	18.88	18.95	-0.07	33.42	33.48	-0.06
20050627	420070014	Pennsylvania	Beaver	37.42	23.28	23.74	-0.47	39.87	40.33	-0.46
20061128	420070014	Pennsylvania	Beaver	37.42	8.14	8.13	0.01	33.91	34.09	-0.18
20070524	420070014	Pennsylvania	Beaver	37.42	17.11	17.45	-0.34	29.43	29.77	-0.34
20030626	420033007	Pennsylvania	Allegheny	37.40	18.77	19.16	-0.39	48.80	49.19	-0.39
20040924	420033007	Pennsylvania	Allegheny	37.40	18.46	18.31	0.15	32.63	32.48	0.16
20050627	420033007	Pennsylvania	Allegheny	37.40	9.78	9.99	-0.20	25.69	25.89	-0.20
20060710	420033007	Pennsylvania	Allegheny	37.40	16.58	16.44	0.14	29.36	29.22	0.14
20070804	420033007	Pennsylvania	Allegheny	37.40	16.21	16.07	0.14	28.71	28.57	0.14
20031103	10730023	Alabama	Jefferson	37.33	9.29	9.33	-0.03	31.67	31.74	-0.07
20040723	10730023	Alabama	Jefferson	37.33	15.32	14.89	0.42	34.09	33.66	0.42
20050914	10730023	Alabama	Jefferson	37.33	18.25	17.74	0.51	40.51	40.01	0.51
20061216	10730023	Alabama	Jefferson	37.33	9.49	9.52	-0.03	32.32	32.39	-0.07
20070521	10730023	Alabama	Jefferson	37.33	14.70	14.51	0.19	35.19	35.00	0.19
20031009	550790026	Wisconsin	Milwaukee	37.24	5.20	5.21	-0.01	25.52	25.92	-0.40
20040110	550790026	Wisconsin	Milwaukee	37.24	6.79	6.73	0.05	24.30	25.54	-1.24
20050203	550790026	Wisconsin	Milwaukee	37.24	10.23	10.15	0.08	36.38	38.25	-1.87
20061125	550790026	Wisconsin	Milwaukee	37.24	7.52	7.53	-0.01	36.69	37.27	-0.58
20070220	550790026	Wisconsin	Milwaukee	37.24	9.80	9.73	0.07	34.89	36.68	-1.79
20030813	180970043	Indiana	Marion	37.20	22.54	21.93	0.61	33.45	32.83	0.62
20040720	180970043	Indiana	Marion	37.20	18.80	18.29	0.51	27.99	27.47	0.52
20050203	180970043	Indiana	Marion	37.20	11.59	11.23	0.36	39.74	41.35	-1.61
20060725	180970043	Indiana	Marion	37.20	22.30	21.69	0.61	33.10	32.49	0.61
20070726	180970043	Indiana	Marion	37.20	23.14	22.51	0.63	34.33	33.70	0.63
20030608	261470005	Michigan	St Clair	37.14	21.35	21.04	0.31	31.27	30.97	0.30
20040903	261470005	Michigan	St Clair	37.14	18.69	18.47	0.22	28.00	27.77	0.23
20051004	261470005	Michigan	St Clair	37.14	8.97	9.03	-0.07	42.74	44.20	-1.46
20060222	261470005	Michigan	St Clair	37.14	8.48	8.35	0.13	34.81	35.29	-0.48
20070921	261470005	Michigan	St Clair	37.14	20.37	20.13	0.25	30.47	30.22	0.25
20030913	550790043	Wisconsin	Milwaukee	37.10	19.39	19.02	0.36	32.92	32.64	0.27
20040906	550790043	Wisconsin	Milwaukee	37.10	20.64	20.25	0.39	35.01	34.72	0.29
20051224	550790043	Wisconsin	Milwaukee	37.10	6.47	6.52	-0.05	31.98	32.51	-0.53
20060329	550790043	Wisconsin	Milwaukee	37.10	10.86	10.81	0.05	39.24	41.14	-1.90
20071211	550790043	Wisconsin	Milwaukee	37.10	6.83	6.89	-0.06	33.76	34.31	-0.56
20030202	180890026	Indiana	Lake	37.06	10.11	10.06	0.05	36.79	37.46	-0.67
20040304	180890026	Indiana	Lake	37.06	9.35	9.30	0.05	34.06	34.68	-0.62
20050802	180890026	Indiana	Lake	37.06	17.33	16.97	0.36	36.60	36.24	0.37
20060719	180890026	Indiana	Lake	37.06	12.00	11.75	0.25	25.49	25.23	0.26
20071120	180890026	Indiana	Lake	37.06	8.42	8.51	-0.09	29.63	30.13	-0.49
20030813	180970081	Indiana	Marion	36.96	21.82	21.23	0.59	31.92	31.32	0.60
20040912	180970081	Indiana	Marion	36.96	19.19	18.67	0.52	28.14	27.61	0.53
20050627	180970081	Indiana	Marion	36.96	25.22	24.99	0.22	41.31	41.09	0.22
20060818	180970081	Indiana	Marion	36.96	20.97	20.40	0.57	30.69	30.12	0.57
20070617	180970081	Indiana	Marion	36.96	20.42	20.24	0.18	33.55	33.37	0.18
20030726	180970066	Indiana	Marion	36.92	23.32	22.68	0.63	34.78	34.14	0.64
20040608	180970066	Indiana	Marion	36.92	16.60	16.45	0.15	28.16	28.01	0.15
20050203	180970066	Indiana	Marion	36.92	11.63	11.27	0.36	39.40	41.01	-1.62
20060818	180970066	Indiana	Marion	36.92	21.40	20.82	0.58	31.96	31.38	0.59
20070617	180970066	Indiana	Marion	36.92	20.50	20.32	0.18	34.67	34.48	0.18
20030316	171191007	Illinois	Madison	36.83	12.14	11.83	0.31	35.89	39.65	-3.76
20040218	171191007	Illinois	Madison	36.83	10.51	10.24	0.27	31.15	34.40	-3.26
20050808	171191007	Illinois	Madison	36.83	26.21	25.45	0.76	39.05	38.28	0.76
20060429	171191007	Illinois	Madison	36.83	13.21	13.07	0.13	32.56	32.51	0.05
20070617	171191007	Illinois	Madison	36.83	12.84	12.71	0.13	31.66	31.61	0.05
20030202	550790010	Wisconsin	Milwaukee	36.71	8.38	8.34	0.04	29.59	31.06	-1.47
20040905	550790010	Wisconsin	Milwaukee	36.71	19.66	19.30	0.37	32.77	32.49	0.28
20050203	550790010	Wisconsin	Milwaukee	36.71	9.78	9.74	0.04	34.48	36.20	-1.71
20060329	550790010	Wisconsin	Milwaukee	36.71	10.30	10.25	0.04	36.26	38.07	-1.80
20070530	550790010	Wisconsin	Milwaukee	36.71	18.16	18.28	-0.12	35.57	35.89	-0.32
20030301	390170003	Ohio	Butler	36.59	15.51	14.95	0.56	35.99	38.23	-2.24
20040924	390170003	Ohio	Butler	36.59	23.08	22.70	0.38	30.19	29.80	0.38
20050203	390170003	Ohio	Butler	36.59	17.30	16.67	0.63	40.07	42.58	-2.50
20060710	390170003	Ohio	Butler	36.59	18.68	18.37	0.31	24.52	24.21	0.31
20070524	390170003	Ohio	Butler	36.59	19.80	19.78	0.02	31.48	31.45	0.02
20030316	170316005	Illinois	Cook	36.42	7.88	7.89	0.00	32.58	33.06	-0.48
20041229	170316005	Illinois	Cook	36.42	9.16	9.06	0.10	35.38	36.53	-1.15
20051221	170316005	Illinois	Cook	36.42	9.55	9.45	0.10	36.86	38.07	-1.20
20060117	170316005	Illinois	Cook	36.42	5.91	5.92	0.00	24.56	24.92	-0.36
20070530	170316005	Illinois	Cook	36.42	10.69	10.41	0.28	31.40	31.16	0.24
20030807	420031008	Pennsylvania	Allegheny	36.35	19.65	19.60	0.05	33.83	33.78	0.05
20040608	420031008	Pennsylvania	Allegheny	36.35	21.08	21.36	-0.28	36.45	36.74	-0.28
20050624	420031008	Pennsylvania	Allegheny	36.35	19.15	19.41	-0.26	33.17	33.43	-0.26
20060818	420031008	Pennsylvania	Allegheny	36.35	17.70	17.66	0.04	30.53	30.49	0.05
20070828	420031008	Pennsylvania	Allegheny	36.35	18.70	18.65	0.04	32.22	32.17	0.05
20030418	261610008	Michigan	Washtenaw	36.32	24.35	24.13	0.21	32.39	32.18	0.21
20041229	261610008	Michigan	Washtenaw	36.32	5.03	5.10	-0.06	26.73	29.37	-2.64
20050206	261610008	Michigan	Washtenaw	36.32	12.78	12.58	0.20	45.91	47.04	-1.13
20061225	261610008	Michigan	Washtenaw	36.32	5.00	5.06	-0.06	26.56	29.19	-2.62
20070906	261610008	Michigan	Washtenaw	36.32	16.15	15.85	0.30	28.65	28.35	0.31

20030202	170312001	Illinois	Cook	36.12	9.27	9.08	0.19	34.34	34.58	-0.24
20040903	170312001	Illinois	Cook	36.12	16.44	15.91	0.53	32.57	32.04	0.53
20050203	170312001	Illinois	Cook	36.12	10.27	10.05	0.21	37.98	38.24	-0.26
20060719	170312001	Illinois	Cook	36.12	11.94	11.56	0.38	23.80	23.41	0.39
20070530	170312001	Illinois	Cook	36.12	14.77	14.40	0.37	31.12	30.76	0.36
20030316	170310052	Illinois	Cook	36.07	8.17	8.13	0.04	31.22	31.69	-0.47
20040904	170310052	Illinois	Cook	36.07	16.15	15.79	0.37	31.64	31.27	0.37
20051221	170310052	Illinois	Cook	36.07	9.96	9.87	0.08	39.51	40.60	-1.09
20060117	170310052	Illinois	Cook	36.07	6.84	6.81	0.03	26.24	26.63	-0.39
20070220	170310052	Illinois	Cook	36.07	8.73	8.68	0.04	33.33	33.83	-0.50
20030301	421330008	Pennsylvania	York	36.06	16.99	16.83	0.17	42.70	43.70	-1.00
20040224	421330008	Pennsylvania	York	36.06	11.23	11.12	0.11	28.39	29.05	-0.66
20050814	421330008	Pennsylvania	York	36.06	26.28	26.01	0.28	35.00	34.72	0.28
20060216	421330008	Pennsylvania	York	36.06	11.01	10.90	0.11	27.83	28.48	-0.65
20070226	421330008	Pennsylvania	York	36.06	13.39	13.26	0.13	33.74	34.53	-0.79
20030301	261630015	Michigan	Wayne	36.00	7.71	7.62	0.09	28.82	29.47	-0.66
20040608	261630015	Michigan	Wayne	36.00	19.87	19.80	0.07	30.54	30.47	0.07
20050913	261630015	Michigan	Wayne	36.00	26.59	26.31	0.28	42.00	41.72	0.28
20060222	261630015	Michigan	Wayne	36.00	8.44	8.34	0.10	31.52	32.23	-0.72
20070530	261630015	Michigan	Wayne	36.00	18.75	18.68	0.07	28.85	28.78	0.07
20030910	10732003	Alabama	Jefferson	35.94	11.52	11.11	0.40	29.68	29.27	0.40
20040817	10732003	Alabama	Jefferson	35.94	12.37	11.94	0.43	31.84	31.40	0.43
20050623	10732003	Alabama	Jefferson	35.94	10.58	10.63	-0.05	37.80	37.85	-0.05
20060201	10732003	Alabama	Jefferson	35.94	7.09	7.13	-0.04	35.12	35.26	-0.14
20070805	10732003	Alabama	Jefferson	35.94	12.21	11.78	0.43	31.42	30.99	0.43
20030301	390618001	Ohio	Hamilton	35.85	9.87	9.61	0.26	31.77	32.92	-1.14
20040720	390618001	Ohio	Hamilton	35.85	17.50	17.31	0.20	27.48	27.28	0.20
20050913	390618001	Ohio	Hamilton	35.85	26.68	26.38	0.30	41.62	41.32	0.30
20060908	390618001	Ohio	Hamilton	35.85	19.02	18.81	0.21	29.83	29.61	0.22
20070906	390618001	Ohio	Hamilton	35.85	19.34	19.12	0.22	30.31	30.09	0.22
20031114	171190023	Illinois	Madison	35.81	9.86	9.55	0.31	33.44	34.39	-0.95
20040729	171190023	Illinois	Madison	35.81	21.38	20.76	0.62	30.77	30.14	0.62
20050907	171190023	Illinois	Madison	35.81	25.55	24.81	0.74	36.68	35.94	0.74
20060411	171190023	Illinois	Madison	35.81	10.48	10.37	0.11	28.83	28.79	0.04
20030821	420031301	Pennsylvania	Allegheny	35.65	24.28	24.21	0.07	40.13	40.06	0.08
20040912	420031301	Pennsylvania	Allegheny	35.65	18.39	18.34	0.05	30.52	30.47	0.06
20050419	420031301	Pennsylvania	Allegheny	35.65	14.97	15.23	-0.26	30.96	31.22	-0.26
20061110	420031301	Pennsylvania	Allegheny	35.65	6.83	6.86	-0.03	31.27	31.32	-0.05
20070807	420031301	Pennsylvania	Allegheny	35.65	21.02	20.96	0.06	34.81	34.75	0.07
20030826	391130032	Ohio	Montgomery	35.61	26.88	26.61	0.27	35.23	34.95	0.28
20040903	391130032	Ohio	Montgomery	35.61	20.29	20.08	0.21	26.71	26.50	0.21
20050203	391130032	Ohio	Montgomery	35.61	4.90	4.75	0.14	39.86	41.17	-1.31
20060710	391130032	Ohio	Montgomery	35.61	18.89	18.70	0.19	24.91	24.71	0.19
20070602	391130032	Ohio	Montgomery	35.61	20.63	20.47	0.16	31.34	31.18	0.16
20030821	420030116	Pennsylvania	Allegheny	35.59	15.73	15.51	0.22	34.86	34.63	0.23

*the 98th percentile days were chosen based on CAMx.

Table Appendix B-2. Comparison of Sulfate and Total $PM_{2.5}$ for 98th Percentile Days* for the 2014 Final Remedy.

					Sulfate			Total PM2.5		
Future Date	**Monitor Identification Number**	**State**	**County**	**2012 Base Case Max. DV**	**CAMx**	**AQAT**	**Difference (CAMx-AQAT), Sulfate**	**CAMx**	**AQAT**	**Difference (CAMx-AQAT), Total PM2.5**
20050418	420030064	Pennsylvania	Allegheny	59.93	15.80	16.01	-0.22	47.16	47.68	-0.52
20030324	420030064	Pennsylvania	Allegheny	59.93	9.93	10.09	-0.15	50.84	51.30	-0.46
20041222	420030064	Pennsylvania	Allegheny	59.93	10.33	10.44	-0.11	46.29	46.59	-0.30
20061128	420030064	Pennsylvania	Allegheny	59.93	9.25	9.34	-0.10	41.48	41.75	-0.27
20071031	420030064	Pennsylvania	Allegheny	59.93	8.33	8.42	-0.09	37.41	37.65	-0.24
20030626	420030093	Pennsylvania	Allegheny	44.40	9.44	9.65	-0.21	37.96	38.57	-0.61
20040608	420030093	Pennsylvania	Allegheny	44.40	7.86	8.03	-0.17	31.68	32.19	-0.51
20050913	420030093	Pennsylvania	Allegheny	44.40	9.81	9.94	-0.13	31.65	32.08	-0.43
20070524	420030093	Pennsylvania	Allegheny	44.40	5.45	5.57	-0.12	22.14	22.49	-0.35
20060710	420030093	Pennsylvania	Allegheny	44.40	7.17	7.27	-0.09	23.28	23.59	-0.31
20070524	390350038	Ohio	Cuyahoga	41.84	14.76	15.07	-0.31	25.64	26.55	-0.91
20041115	390350038	Ohio	Cuyahoga	41.84	7.18	7.39	-0.21	32.28	33.71	-1.43
20050206	390350038	Ohio	Cuyahoga	41.84	10.43	10.61	-0.18	38.13	39.04	-0.91
20030220	390350038	Ohio	Cuyahoga	41.84	9.08	9.24	-0.16	33.27	34.06	-0.79
20060222	390350038	Ohio	Cuyahoga	41.84	7.61	7.74	-0.13	27.97	28.63	-0.66
20041117	261630016	Michigan	Wayne	41.28	4.47	4.58	-0.11	25.88	26.12	-0.24
20071120	261630016	Michigan	Wayne	41.28	3.91	4.01	-0.09	22.71	22.92	-0.21
20050206	261630016	Michigan	Wayne	41.28	9.73	9.77	-0.04	41.38	41.51	-0.13
20030221	261630016	Michigan	Wayne	41.28	9.18	9.22	-0.04	39.06	39.19	-0.12
20060330	261630016	Michigan	Wayne	41.28	7.72	7.75	-0.03	32.92	33.02	-0.10
20051004	390350060	Ohio	Cuyahoga	40.85	10.79	11.11	-0.32	36.64	37.61	-0.97
20030130	390350060	Ohio	Cuyahoga	40.85	7.08	7.20	-0.12	30.60	31.23	-0.63
20040310	390350060	Ohio	Cuyahoga	40.85	6.79	6.91	-0.12	29.38	29.98	-0.60
20070310	390350060	Ohio	Cuyahoga	40.85	5.56	5.66	-0.10	24.14	24.64	-0.49
20060309	390350060	Ohio	Cuyahoga	40.85	5.17	5.26	-0.09	22.49	22.95	-0.46
20040903	170311016	Illinois	Cook	40.44	9.47	9.60	-0.13	31.23	31.54	-0.32
20050627	170311016	Illinois	Cook	40.44	11.27	11.39	-0.12	39.68	39.97	-0.29
20060818	170311016	Illinois	Cook	40.44	7.32	7.42	-0.10	24.25	24.49	-0.24
20070530	170311016	Illinois	Cook	40.44	7.54	7.62	-0.08	26.71	26.91	-0.19
20030316	170311016	Illinois	Cook	40.44	7.61	7.61	0.00	37.60	37.68	-0.08
20050627	261630033	Michigan	Wayne	39.81	20.76	21.08	-0.32	38.11	38.86	-0.75

20061213	261630033	Michigan	Wayne	39.81	5.22	5.34	-0.12	36.30	36.63	-0.33
20041117	261630033	Michigan	Wayne	39.81	4.17	4.27	-0.10	29.10	29.37	-0.26
20071226	261630033	Michigan	Wayne	39.81	4.07	4.17	-0.10	28.44	28.70	-0.26
20030304	261630033	Michigan	Wayne	39.81	8.26	8.29	-0.03	35.29	35.40	-0.12
20030415	180890022	Indiana	Lake	39.58	21.84	22.04	-0.20	36.94	37.24	-0.30
20041226	180890022	Indiana	Lake	39.58	8.81	8.90	-0.10	37.62	37.82	-0.19
20050116	180890022	Indiana	Lake	39.58	8.86	8.86	0.00	33.76	33.83	-0.07
20070310	180890022	Indiana	Lake	39.58	7.48	7.48	0.00	28.58	28.64	-0.06
20060123	180890022	Indiana	Lake	39.58	6.21	6.21	0.00	23.83	23.88	-0.05
20030626	540090011	West Virginia	Brooke	38.39	16.21	16.52	-0.31	28.97	29.66	-0.69
20040702	540090011	West Virginia	Brooke	38.39	10.20	10.40	-0.20	29.26	29.75	-0.50
20070828	540090011	West Virginia	Brooke	38.39	9.82	10.01	-0.19	28.20	28.68	-0.48
20051112	540090011	West Virginia	Brooke	38.39	5.98	6.09	-0.11	29.12	29.48	-0.36
20061110	540090011	West Virginia	Brooke	38.39	5.38	5.48	-0.10	26.27	26.60	-0.32
20041009	420710007	Pennsylvania	Lancaster	38.37	3.70	3.74	-0.04	29.12	29.21	-0.10
20030313	420710007	Pennsylvania	Lancaster	38.37	10.63	10.64	-0.01	43.55	43.66	-0.11
20050209	420710007	Pennsylvania	Lancaster	38.37	9.32	9.33	-0.01	38.26	38.36	-0.10
20060330	420710007	Pennsylvania	Lancaster	38.37	7.88	7.89	-0.01	32.41	32.50	-0.08
20070301	420710007	Pennsylvania	Lancaster	38.37	7.67	7.68	0.00	31.58	31.66	-0.08
20041229	390350045	Ohio	Cuyahoga	38.13	7.73	7.96	-0.23	26.40	27.61	-1.21
20050305	390350045	Ohio	Cuyahoga	38.13	7.45	7.58	-0.13	27.56	28.20	-0.64
20030319	390350045	Ohio	Cuyahoga	38.13	6.98	7.11	-0.12	25.89	26.49	-0.60
20070310	390350045	Ohio	Cuyahoga	38.13	6.23	6.34	-0.11	23.16	23.69	-0.53
20060222	390350045	Ohio	Cuyahoga	38.13	6.06	6.17	-0.11	22.54	23.06	-0.52
20040702	390811001	Ohio	Jefferson	37.88	9.67	9.85	-0.19	29.82	30.31	-0.49
20030814	390811001	Ohio	Jefferson	37.88	8.57	8.73	-0.16	26.48	26.92	-0.44
20050913	390811001	Ohio	Jefferson	37.88	8.28	8.44	-0.16	25.62	26.04	-0.42
20060117	390811001	Ohio	Jefferson	37.88	7.38	7.51	-0.14	21.68	22.08	-0.40
20070804	390811001	Ohio	Jefferson	37.88	6.41	6.53	-0.12	19.93	20.26	-0.33
20041117	261630019	Michigan	Wayne	37.83	3.86	3.96	-0.10	27.56	27.76	-0.21
20050206	261630019	Michigan	Wayne	37.83	10.63	10.65	-0.03	46.77	46.95	-0.18
20060309	261630019	Michigan	Wayne	37.83	7.32	7.34	-0.02	32.39	32.51	-0.12
20030304	261630019	Michigan	Wayne	37.83	6.83	6.85	-0.02	30.24	30.36	-0.12
20070217	261630019	Michigan	Wayne	37.83	4.94	4.96	-0.01	22.03	22.11	-0.08
20050627	390350065	Ohio	Cuyahoga	37.67	15.41	15.73	-0.33	30.29	31.33	-1.03
20030702	390350065	Ohio	Cuyahoga	37.67	13.52	13.77	-0.24	23.93	24.96	-1.04
20070906	390350065	Ohio	Cuyahoga	37.67	12.98	13.22	-0.23	23.00	23.99	-0.99
20040212	390350065	Ohio	Cuyahoga	37.67	6.42	6.53	-0.11	23.60	24.15	-0.55
20060210	390350065	Ohio	Cuyahoga	37.67	5.61	5.71	-0.10	20.69	21.17	-0.48
20050627	170313301	Illinois	Cook	37.67	12.27	12.36	-0.09	36.65	36.87	-0.22
20070617	170313301	Illinois	Cook	37.67	9.40	9.47	-0.07	28.19	28.35	-0.17
20030214	170313301	Illinois	Cook	37.67	6.19	6.19	0.00	31.42	31.48	-0.06
20040227	170313301	Illinois	Cook	37.67	5.84	5.84	0.00	29.68	29.74	-0.06
20060306	170313301	Illinois	Cook	37.67	4.22	4.22	0.00	21.58	21.62	-0.04
20040608	420070014	Pennsylvania	Beaver	37.42	10.19	10.39	-0.20	23.91	24.41	-0.49
20070602	420070014	Pennsylvania	Beaver	37.42	9.08	9.25	-0.18	21.36	21.80	-0.44
20061128	420070014	Pennsylvania	Beaver	37.42	5.47	5.59	-0.13	31.18	31.55	-0.37
20051127	420070014	Pennsylvania	Beaver	37.42	5.11	5.23	-0.12	29.19	29.53	-0.34
20031105	420070014	Pennsylvania	Beaver	37.42	4.17	4.27	-0.10	23.93	24.21	-0.28
20040924	420033007	Pennsylvania	Allegheny	37.40	9.16	9.32	-0.17	23.11	23.49	-0.38
20030626	420033007	Pennsylvania	Allegheny	37.40	10.68	10.83	-0.15	40.46	40.86	-0.40
20050627	420033007	Pennsylvania	Allegheny	37.40	5.57	5.65	-0.08	21.34	21.55	-0.21
20061125	420033007	Pennsylvania	Allegheny	37.40	1.58	1.60	-0.02	24.46	24.59	-0.13
20071208	420033007	Pennsylvania	Allegheny	37.40	1.37	1.39	-0.01	21.26	21.37	-0.11
20031115	10730023	Alabama	Jefferson	37.33	6.47	6.45	0.01	27.57	27.66	-0.09
20040225	10730023	Alabama	Jefferson	37.33	6.46	6.43	0.04	29.97	30.04	-0.07
20070326	10730023	Alabama	Jefferson	37.33	6.76	6.72	0.04	31.34	31.41	-0.07
20060704	10730023	Alabama	Jefferson	37.33	10.33	10.12	0.21	29.20	29.07	0.13
20050914	10730023	Alabama	Jefferson	37.33	12.19	11.95	0.25	34.37	34.22	0.15
20061125	550790026	Wisconsin	Milwaukee	37.24	6.05	6.12	-0.07	35.65	35.85	-0.20
20071211	550790026	Wisconsin	Milwaukee	37.24	5.52	5.58	-0.06	32.56	32.74	-0.18
20050131	550790026	Wisconsin	Milwaukee	37.24	6.99	6.99	0.00	30.64	30.72	-0.07
20030307	550790026	Wisconsin	Milwaukee	37.24	5.78	5.78	0.00	25.40	25.46	-0.06
20040110	550790026	Wisconsin	Milwaukee	37.24	5.51	5.51	0.00	24.27	24.32	-0.06
20050910	180970043	Indiana	Marion	37.20	16.70	17.10	-0.40	31.49	32.13	-0.64
20070617	180970043	Indiana	Marion	37.20	11.68	12.06	-0.38	24.60	25.26	-0.66
20060818	180970043	Indiana	Marion	37.20	11.97	12.25	-0.29	22.70	23.16	-0.46
20030313	180970043	Indiana	Marion	37.20	5.77	5.82	-0.05	25.92	26.11	-0.19
20040227	180970043	Indiana	Marion	37.20	5.53	5.58	-0.05	24.86	25.04	-0.18
20051004	261470005	Michigan	St Clair	37.14	5.51	5.67	-0.17	40.08	40.84	-0.76
20070524	261470005	Michigan	St Clair	37.14	13.75	13.87	-0.12	23.60	24.09	-0.49
20060222	261470005	Michigan	St Clair	37.14	7.39	7.42	-0.03	34.24	34.36	-0.11
20030307	261470005	Michigan	St Clair	37.14	6.30	6.33	-0.03	29.28	29.38	-0.10
20040325	261470005	Michigan	St Clair	37.14	5.25	5.27	-0.02	24.50	24.58	-0.08
20040906	550790043	Wisconsin	Milwaukee	37.10	11.32	11.38	-0.06	25.66	25.85	-0.20
20060329	550790043	Wisconsin	Milwaukee	37.10	8.88	8.89	-0.01	39.14	39.22	-0.08
20030316	550790043	Wisconsin	Milwaukee	37.10	6.84	6.85	-0.01	30.26	30.32	-0.06
20071120	550790043	Wisconsin	Milwaukee	37.10	5.50	5.50	0.00	30.83	30.91	-0.09
20051224	550790043	Wisconsin	Milwaukee	37.10	5.63	5.63	0.00	31.53	31.61	-0.09
20050203	180890026	Indiana	Lake	37.06	8.03	8.08	-0.05	33.45	33.59	-0.14
20040304	180890026	Indiana	Lake	37.06	7.99	8.04	-0.05	33.28	33.42	-0.14
20030226	180890026	Indiana	Lake	37.06	7.93	7.98	-0.05	33.02	33.16	-0.14
20070220	180890026	Indiana	Lake	37.06	6.10	6.14	-0.04	25.54	25.64	-0.10
20060123	180890026	Indiana	Lake	37.06	5.71	5.74	-0.03	23.90	24.00	-0.10
20050910	180970081	Indiana	Marion	36.96	17.37	17.78	-0.41	32.00	32.66	-0.66
20070617	180970081	Indiana	Marion	36.96	11.14	11.50	-0.36	24.00	24.63	-0.63
20030130	180970081	Indiana	Marion	36.96	5.95	6.00	-0.05	25.86	26.05	-0.19
20060306	180970081	Indiana	Marion	36.96	5.78	5.84	-0.05	25.14	25.33	-0.18
20040224	180970081	Indiana	Marion	36.96	5.28	5.33	-0.05	23.01	23.18	-0.17
20050910	180970066	Indiana	Marion	36.92	16.90	17.31	-0.40	32.11	32.77	-0.65
20070803	180970066	Indiana	Marion	36.92	14.77	15.12	-0.35	28.12	28.70	-0.57
20030801	180970066	Indiana	Marion	36.92	13.85	14.18	-0.33	26.40	26.93	-0.54
20060222	180970066	Indiana	Marion	36.92	5.79	5.84	-0.05	25.66	25.85	-0.19

20040224	180970066	Indiana	Marion	36.92	5.27	5.32	-0.05	23.44	23.61	-0.17
20050227	171191007	Illinois	Madison	36.83	8.60	8.74	-0.13	34.53	34.59	-0.06
20040116	171191007	Illinois	Madison	36.83	6.67	6.77	-0.10	26.89	26.93	-0.04
20060126	171191007	Illinois	Madison	36.83	6.35	6.45	-0.10	25.62	25.66	-0.04
20070220	171191007	Illinois	Madison	36.83	6.05	6.14	-0.09	24.43	24.47	-0.04
20031114	171191007	Illinois	Madison	36.83	6.50	6.54	-0.04	30.13	30.25	-0.11
20060329	550790010	Wisconsin	Milwaukee	36.71	8.42	8.43	-0.01	36.17	36.25	-0.07
20050131	550790010	Wisconsin	Milwaukee	36.71	7.39	7.40	-0.01	31.83	31.89	-0.06
20030202	550790010	Wisconsin	Milwaukee	36.71	6.85	6.86	-0.01	29.52	29.58	-0.06
20040223	550790010	Wisconsin	Milwaukee	36.71	5.59	5.60	-0.01	24.19	24.24	-0.05
20071211	550790010	Wisconsin	Milwaukee	36.71	5.57	5.57	0.00	31.17	31.26	-0.09
20050203	390170003	Ohio	Butler	36.59	12.09	12.27	-0.18	37.83	38.18	-0.35
20070530	390170003	Ohio	Butler	36.59	11.14	11.31	-0.17	23.14	23.56	-0.43
20040924	390170003	Ohio	Butler	36.59	10.97	11.10	-0.14	17.90	18.21	-0.31
20030318	390170003	Ohio	Butler	36.59	7.38	7.49	-0.11	23.28	23.49	-0.21
20060222	390170003	Ohio	Butler	36.59	6.30	6.39	-0.09	19.95	20.13	-0.18
20051221	170316005	Illinois	Cook	36.42	7.64	7.76	-0.12	36.24	36.38	-0.14
20041229	170316005	Illinois	Cook	36.42	7.33	7.44	-0.11	34.78	34.91	-0.13
20070617	170316005	Illinois	Cook	36.42	7.29	7.37	-0.09	29.17	29.36	-0.18
20030316	170316005	Illinois	Cook	36.42	6.87	6.88	-0.01	31.96	32.05	-0.10
20060123	170316005	Illinois	Cook	36.42	5.10	5.10	-0.01	23.84	23.92	-0.07
20040608	420031008	Pennsylvania	Allegheny	36.35	11.00	11.24	-0.24	26.03	26.61	-0.58
20050627	420031008	Pennsylvania	Allegheny	36.35	10.04	10.26	-0.22	23.81	24.35	-0.53
20030821	420031008	Pennsylvania	Allegheny	36.35	9.99	10.15	-0.16	24.71	25.19	-0.48
20070310	420031008	Pennsylvania	Allegheny	36.35	6.69	6.81	-0.12	24.20	24.56	-0.36
20060222	420031008	Pennsylvania	Allegheny	36.35	6.01	6.12	-0.11	21.80	22.12	-0.33
20051004	261610008	Michigan	Washtenaw	36.32	3.74	3.86	-0.12	32.73	32.74	-0.02
20031009	261610008	Michigan	Washtenaw	36.32	3.34	3.45	-0.11	29.24	29.26	-0.01
20061225	261610008	Michigan	Washtenaw	36.32	3.11	3.22	-0.10	27.33	27.34	-0.01
20071226	261610008	Michigan	Washtenaw	36.32	2.55	2.63	-0.08	22.45	22.46	-0.01
20040304	261610008	Michigan	Washtenaw	36.32	5.96	5.99	-0.03	25.67	25.77	-0.11
20030403	170312001	Illinois	Cook	36.12	12.30	12.41	-0.11	32.55	32.76	-0.21
20070617	170312001	Illinois	Cook	36.12	10.12	10.20	-0.09	26.85	27.02	-0.17
20050203	170312001	Illinois	Cook	36.12	9.00	9.00	-0.01	37.12	37.19	-0.07
20040227	170312001	Illinois	Cook	36.12	6.42	6.43	0.00	26.63	26.68	-0.05
20060117	170312001	Illinois	Cook	36.12	4.88	4.89	0.00	20.37	20.41	-0.04
20041230	170310052	Illinois	Cook	36.07	5.78	5.90	-0.11	28.34	28.53	-0.19
20061229	170310052	Illinois	Cook	36.07	5.14	5.24	-0.10	25.24	25.41	-0.17
20050205	170310052	Illinois	Cook	36.07	7.63	7.65	-0.02	32.74	32.86	-0.11
20070308	170310052	Illinois	Cook	36.07	7.31	7.34	-0.02	31.42	31.53	-0.11
20030226	170310052	Illinois	Cook	36.07	6.77	6.79	-0.02	29.11	29.21	-0.10
20071208	421330008	Pennsylvania	York	36.06	4.92	5.00	-0.09	29.97	30.07	-0.10
20030301	421330008	Pennsylvania	York	36.06	14.24	14.33	-0.08	41.07	41.20	-0.14
20041123	421330008	Pennsylvania	York	36.06	4.45	4.53	-0.08	27.17	27.26	-0.09
20050206	421330008	Pennsylvania	York	36.06	11.35	11.41	-0.07	32.81	32.92	-0.11
20060216	421330008	Pennsylvania	York	36.06	9.23	9.28	-0.05	26.77	26.86	-0.09
20051004	261630015	Michigan	Wayne	36.00	5.94	6.09	-0.14	36.16	36.50	-0.34
20041229	261630015	Michigan	Wayne	36.00	4.53	4.63	-0.11	27.65	27.91	-0.26
20060222	261630015	Michigan	Wayne	36.00	7.40	7.43	-0.03	31.22	31.32	-0.10
20030214	261630015	Michigan	Wayne	36.00	6.73	6.76	-0.03	28.46	28.55	-0.09
20070325	261630015	Michigan	Wayne	36.00	5.32	5.34	-0.02	22.58	22.65	-0.07
20061210	10732003	Alabama	Jefferson	35.94	6.17	6.24	-0.07	31.19	31.44	-0.26
20070815	10732003	Alabama	Jefferson	35.94	7.88	7.76	0.12	27.22	27.18	0.04
20030415	10732003	Alabama	Jefferson	35.94	5.24	5.09	0.14	25.94	25.93	0.01
20050921	10732003	Alabama	Jefferson	35.94	9.82	9.68	0.14	33.82	33.77	0.05
20040610	10732003	Alabama	Jefferson	35.94	5.90	5.74	0.16	29.17	29.16	0.02
20050910	390618001	Ohio	Hamilton	35.85	13.46	13.74	-0.27	29.11	29.64	-0.53
20070527	390618001	Ohio	Hamilton	35.85	9.58	9.76	-0.18	22.95	23.35	-0.40
20030316	390618001	Ohio	Hamilton	35.85	5.98	6.14	-0.15	25.39	25.65	-0.26
20040218	390618001	Ohio	Hamilton	35.85	5.74	5.88	-0.15	24.37	24.62	-0.25
20060222	390618001	Ohio	Hamilton	35.85	5.41	5.55	-0.14	23.00	23.23	-0.24
20050227	171190023	Illinois	Madison	35.81	9.01	9.15	-0.14	33.18	33.22	-0.04
20030304	171190023	Illinois	Madison	35.81	8.41	8.54	-0.13	30.99	31.03	-0.04
20060222	171190023	Illinois	Madison	35.81	6.75	6.85	-0.10	24.96	25.00	-0.03
20040424	171190023	Illinois	Madison	35.81	6.03	6.08	-0.05	23.84	23.99	-0.15
20070906	420031301	Pennsylvania	Allegheny	35.65	11.73	11.91	-0.18	26.27	26.71	-0.44
20030221	420031301	Pennsylvania	Allegheny	35.65	8.65	8.81	-0.17	28.93	29.33	-0.40
20060710	420031301	Pennsylvania	Allegheny	35.65	10.34	10.50	-0.16	23.22	23.61	-0.39
20050624	420031301	Pennsylvania	Allegheny	35.65	8.37	8.53	-0.15	24.57	24.92	-0.35
20040512	420031301	Pennsylvania	Allegheny	35.65	7.82	7.96	-0.14	22.97	23.30	-0.32
20030624	391130032	Ohio	Montgomery	35.61	13.74	13.97	-0.23	26.72	27.21	-0.49
20070530	391130032	Ohio	Montgomery	35.61	11.68	11.88	-0.20	22.80	23.21	-0.42
20050125	391130032	Ohio	Montgomery	35.61	2.34	2.37	-0.03	25.66	25.87	-0.21
20040131	391130032	Ohio	Montgomery	35.61	1.84	1.87	-0.02	20.36	20.53	-0.17
20060309	391130032	Ohio	Montgomery	35.61	1.74	1.76	-0.02	19.22	19.37	-0.16
20051004	420030116	Pennsylvania	Allegheny	35.59	8.27	8.46	-0.19	24.05	24.45	-0.40
20040608	420030116	Pennsylvania	Allegheny	35.59	8.95	9.12	-0.17	26.74	27.25	-0.51
20030821	420030116	Pennsylvania	Allegheny	35.59	7.42	7.58	-0.16	26.23	26.70	-0.47

*the 98th percentile days were chosen based on CAMx.

Appendix C: Description of Excel Spreadsheet Data Files for Transport Rule Significant Contribution Analysis

EPA placed the following Excel spreadsheet file in the Transport Rule docket.

The annual and quarterly emissions for all AQAT simulations can be found in this file.
AQAT_emissions.xlsx

These files contain the 24-hour PM2.5 2012 base case and 2014 AQAT Calibration Scenario contributions.
QTR1_base_and_AQAT_calibration_scenario_contributions.xlsx
QTR2_base_and_AQAT_calibration_scenario_contributions.xlsx
QTR3_base_and_AQAT_calibration_scenario_contributions.xlsx
QTR4_base_and_AQAT_calibration_scenario_contributions.xlsx

The annual PM2.5 and 24-hour PM2.5 calibration factors can be found in the respective files.
Annual PM Calib Factors.xlsx
Daily PM Calibration Factors.xlsx

These files contain the quarterly contributions and calibrated Relative Response Factors (RRFs) for all 24-hour PM2.5 simulations.
dailyPM_adjusted sulfate contributions and RRF_2014_base.xlsx
dailyPM_adjusted sulfate contributions and RRF_2012_base_wleakage.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_500CT.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_1600CT.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_2300CT.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_2800CT.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_3300CT.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_10000CT.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_1600_remedy.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_2300_remedy.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_10000_remedy.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_final_remedy_sensitivity.xlsx

These files contain the quarterly contributions and calibrated RRFs for the variability assessments. The files in the list assume that the home state is held constant at the $2300/ton level. The number associated with "var" in the title notes the level of emissions variation above the level of the budget in the simulation.
dailyPM_adjusted sulfate contributions and RRF_2014_2300CT_21var_home_2300.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_2300CT_20var_home_2300.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_2300CT_18var_home_2300.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_2300CT_15var_home_2300.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_2300CT_10var_home_2300.xlsx
dailyPM_adjusted sulfate contributions and RRF_2014_2300CT_05var_home_2300.xlsx

This file contains a summary of the estimated 98th percentile values and resulting average and maximum design values for all 24-hour PM2.5 AQAT cost threshold level, variability analyses, and remedy simulations.
dailyPM_allyears_high_quarters.xlsx

These files apply the RRFs to each of the 32 days per year for each of the 5 years of available receptor estimates. The result is the estimated 24-hour PM2.5 concentration for that day. The 98th percentile day is also identified in these files. They are all in 2014 unless otherwise specified in the title of the file.

dailyPM_all_years_all_quarters_base.xlsx
dailyPM_all_years_all_quarters_base_500CT.xlsx
dailyPM_all_years_all_quarters_base_1600CT.xlsx
dailyPM_all_years_all_quarters_base_2300CT.xlsx
dailyPM_all_years_all_quarters_base_2800CT.xlsx
dailyPM_all_years_all_quarters_base_3300CT.xlsx
dailyPM_all_years_all_quarters_base_10000CT.xlsx
dailyPM_all_years_all_quarters_base_2012_leakage.xlsx
dailyPM_all_years_all_quarters_1600_remedy.xlsx
dailyPM_all_years_all_quarters_2300_remedy.xlsx
dailyPM_all_years_all_quarters_10000_remedy.xlsx
dailyPM_all_years_all_quarters_final_remedy_sensitivity.xlsx

These are the same files as above, but were used in the variability analysis. The home state was controlled and held constant at the $2300/ton cost threshold level. States that were linked to the particular receptor were controlled at the $2300/ton cost threshold level plust the variability limit. The level of variability is noted in the name of the file.
dailyPM_all_years_all_quarters_base_2300CT_21perc_whomeat2300.xlsx
dailyPM_all_years_all_quarters_base_2300CT_20perc_whomeat2300.xlsx
dailyPM_all_years_all_quarters_base_2300CT_18perc_whomeat2300.xlsx
dailyPM_all_years_all_quarters_base_2300CT_15perc_whomeat2300.xlsx
dailyPM_all_years_all_quarters_base_2300CT_10perc_whomeat2300.xlsx
dailyPM_all_years_all_quarters_base_2300CT_05perc_whomeat2300.xlsx

The annualPM25 AQAT.xlsx file contains the base contributions, AQAT calibration scenario contributions, calibrated contributions, and estimated design values for all annual PM2.5 AQAT simulations.

The AQAT vs. CAMx.xlsx file contains the 2014 base case and 2014 remedy comparisons for AQAT and CAMx.

Appendix D: Description of Relationship Assumed between Monitor Location and Nonattainment Areas

In Table VI.C-2 of the preamble is a list of the number of projected nonattainment and maintenance areas. These were counted using the number of receptors from Tables C-3, C-4, C-5, and C-6 in this TSD and noting the nonattainment area that they are associated with (found in Tables Appendix D-1 and Appendix D-2). Note that for the 24-hour $PM_{2.5}$ standard, some areas with the receptors identified as having potential nonattainment and/or maintenance issues have not been designated as being nonattainment. For purposes of the final Transport Rule summary of results in Table VI.C-2 of the preamble, for these areas, EPA is using the annual $PM_{2.5}$ NAAQS nonattainment area designation. For example, for 24-hour $PM_{2.5}$, the receptors in Cook, IL and Lake, IN that are projected to be maintenance in the Transport Rule modeling are associated with their annual $PM_{2.5}$nonattainment area designation (Chicago-Gary-Lake County, IL-IN) since they have not been designated for the 24-hour $PM_{2.5}$NAAQS.

Table Appendix D-1. Relationship between the Monitor Receptors and Nonattainment Areas for the Annual $PM_{2.5}$ NAAQS.

Monitor Identification Number	State	County	CAMx 2012 Base Case Avg. DV ($\mu g/m^3$)	CAMx 2012 Base Case Max. DV ($\mu g/m^3$)	Area
420030064	Pennsylvania	Allegheny	17.94	18.33	Liberty-Clairton, PA
390350038	Ohio	Cuyahoga	15.99	16.66	Cleveland-Akron-Lorain, OH
10730023	Alabama	Jefferson	16.15	16.46	Birmingham, AL
390618001	Ohio	Hamilton	16.01	16.33	Cincinnati-Hamilton, OH-KY-IN
261630033	Michigan	Wayne	15.73	16.32	Detroit-Ann Arbor, MI
390350060	Ohio	Cuyahoga	15.67	16.18	Cleveland-Akron-Lorain, OH
390610014	Ohio	Hamilton	15.76	15.98	Cincinnati-Hamilton, OH-KY-IN
390610042	Ohio	Hamilton	15.40	15.77	Cincinnati-Hamilton, OH-KY-IN
171191007	Illinois	Madison	15.46	15.73	St. Louis, MO-IL
10732003	Alabama	Jefferson	15.16	15.64	Birmingham, AL
390350045	Ohio	Cuyahoga	15.14	15.61	Cleveland-Akron-Lorain, OH
180970081	Indiana	Marion	14.86	15.16	Indianapolis, IN
131210039	Georgia	Fulton	15.07	15.10	Atlanta, GA
390617001	Ohio	Hamilton	14.74	15.10	Cincinnati-Hamilton, OH-KY-IN
390350065	Ohio	Cuyahoga	14.67	15.10	Cleveland-Akron-Lorain, OH
180970083	Indiana	Marion	14.71	15.06	Indianapolis, IN

Table Appendix D-2. Relationship between the Monitor Receptors and Nonattainment Areas* for the 24-hour $PM_{2.5}$ NAAQS.

Monitor Identification Number	State	County	CAMx 2012 Base Case Avg. DV (μg/m³)	CAMx 2012 Base Case Max. DV (μg/m³)	Area
420030064	Pennsylvania	Allegheny	56.71	59.93	Liberty-Clairton, PA
420030093	Pennsylvania	Allegheny	39.11	44.40	Pittsburgh-Beaver Valley, PA
390350038	Ohio	Cuyahoga	39.46	41.84	Cleveland-Akron-Lorain, OH
261630016	Michigan	Wayne	38.99	41.28	Detroit-Ann Arbor, MI
390350060	Ohio	Cuyahoga	37.78	40.85	Cleveland-Akron-Lorain, OH
170311016	Illinois	Cook	37.58	40.44	Chicago-Gary-Lake County, IL-IN*
261630033	Michigan	Wayne	39.48	39.81	Detroit-Ann Arbor, MI
180890022	Indiana	Lake	34.94	39.58	Chicago-Gary-Lake County, IL-IN*
540090011	West Virginia	Brooke	37.57	38.39	Steubenville-Weirton, OH-WV
420710007	Pennsylvania	Lancaster	35.98	38.37	Lancaster, PA
390350045	Ohio	Cuyahoga	34.80	38.13	Cleveland-Akron-Lorain, OH
390811001	Ohio	Jefferson	34.56	37.88	Steubenville-Weirton, OH-WV
261630019	Michigan	Wayne	37.34	37.83	Detroit-Ann Arbor, MI
390350065	Ohio	Cuyahoga	34.91	37.67	Cleveland-Akron-Lorain, OH
170313301	Illinois	Cook	34.97	37.67	Chicago-Gary-Lake County, IL-IN*
420070014	Pennsylvania	Beaver	36.21	37.42	Pittsburgh-Beaver Valley, PA
420033007	Pennsylvania	Allegheny	32.40	37.40	Liberty-Clairton, PA
10730023	Alabama	Jefferson	36.96	37.33	Birmingham, AL
550790026	Wisconsin	Milwaukee	33.62	37.24	Milwaukee-Racine, WI
180970043	Indiana	Marion	35.76	37.20	Indianapolis, IN*
261470005	Michigan	St Clair	36.23	37.14	Detroit-Ann Arbor, MI
550790043	Wisconsin	Milwaukee	36.21	37.10	Milwaukee-Racine, WI
180890026	Indiana	Lake	34.08	37.06	Chicago-Gary-Lake County, IL-IN*
180970081	Indiana	Marion	35.85	36.96	Indianapolis, IN*
180970066	Indiana	Marion	35.73	36.92	Indianapolis, IN*
171191007	Illinois	Madison	36.59	36.83	St. Louis, MO-IL*
550790010	Wisconsin	Milwaukee	35.47	36.71	Milwaukee-Racine, WI
390170003	Ohio	Butler	34.40	36.59	Cincinnati-Hamilton, OH-KY-IN*
170316005	Illinois	Cook	34.12	36.42	Chicago-Gary-Lake County, IL-IN*
420031008	Pennsylvania	Allegheny	35.04	36.35	Pittsburgh-Beaver Valley, PA
261610008	Michigan	Washtenaw	35.05	36.32	Detroit-Ann Arbor, MI
170312001	Illinois	Cook	33.62	36.12	Chicago-Gary-Lake County, IL-IN*
170310052	Illinois	Cook	34.94	36.07	Chicago-Gary-Lake County, IL-IN*
421330008	Pennsylvania	York	33.38	36.06	Harrisburg-Lebanon-Carlisle, PA
261630015	Michigan	Wayne	35.55	36.00	Detroit-Ann Arbor, MI
10732003	Alabama	Jefferson	35.31	35.94	Birmingham, AL
390618001	Ohio	Hamilton	35.29	35.85	Cincinnati-Hamilton, OH-KY-IN*
171190023	Illinois	Madison	35.11	35.81	St. Louis, MO-IL*
420031301	Pennsylvania	Allegheny	33.95	35.65	Pittsburgh-Beaver Valley, PA
391130032	Ohio	Montgomery	33.68	35.61	Dayton-Springfield, OH*
420030116	Pennsylvania	Allegheny	35.59	35.59	Pittsburgh-Beaver Valley, PA

* Indicates that the receptor is not associated with a designated nonattainment area for the 24-hour $PM_{2.5}$ NAAQS. Consequently, only for purposes of this analysis, EPA associated the receptor with the area designated with respect to the annual $PM_{2.5}$ NAAQS.

Appendix E: Comparison of Estimated 24-hour $PM_{2.5}$ Design Values for the Final Transport Rule Remedy and Final Remedy Sensitivity.[13]

This appendix contains the AQAT estimates for the final Transport Rule remedy that was modeled in CAMx as well as the Final Remedy Sensitivity. The comparison of these two estimates show the air quality effects of the larger variability limits for SO_2 on $PM_{2.5}$ concentrations.

[13]" Final Remedy Sensitivity" models the air quality-assured trading final remedy described in the Transport Rule preamble with variability limits of 18% for SO_2 and Annual NO_x, and 21% for ozone-season NO_x. See run description in Appendix Table A-1.

Table Appendix E-1. Average and Maximum $PM_{2.5}$ DVs ($\mu g/m^3$) in 2014 for the Final Transport Rule Remedy (as modeled in AQAT) and for Final Remedy Sensitivity.

Site ID	**State**	**County**	**Average DV**		**Difference in air quality between Final Remedy Sensitivity and the remedy for Avg. DV.**	**Maximum DV**		**Difference in air quality between Final Remedy Sensitivity and the remedy for Max DV.**
			remedy	**Final Remedy Sensitivity**		**remedy**	**Final Remedy Sensitivity**	
420030064	Pennsylvania	Allegheny	45.45	45.59	0.14	48.52	48.65	0.12
420030093	Pennsylvania	Allegheny	29.88	30.02	0.14	34.28	34.43	0.15
390350038	Ohio	Cuyahoga	33.46	33.52	0.06	35.39	35.44	0.05
261630016	Michigan	Wayne	33.88	33.94	0.06	35.61	35.67	0.06
390350060	Ohio	Cuyahoga	30.51	30.56	0.06	32.94	33.00	0.06
170311016	Illinois	Cook	32.95	33.06	0.11	36.40	36.50	0.10
261630033	Michigan	Wayne	34.74	34.90	0.15	34.95	35.11	0.16
180890022	Indiana	Lake	32.31	32.34	0.03	36.30	36.36	0.06
540090011	West Virginia	Brooke	28.83	28.95	0.12	29.63	29.80	0.17
420710007	Pennsylvania	Lancaster	34.87	34.88	0.01	37.08	37.09	0.01
390350045	Ohio	Cuyahoga	26.23	26.29	0.05	27.43	27.50	0.07
390811001	Ohio	Jefferson	25.57	25.71	0.14	27.76	27.93	0.17
261630019	Michigan	Wayne	34.87	34.92	0.04	35.74	35.79	0.05
390350065	Ohio	Cuyahoga	25.95	26.07	0.12	26.81	26.96	0.15
170313301	Illinois	Cook	30.35	30.39	0.04	32.70	32.73	0.04
420070014	Pennsylvania	Beaver	27.39	27.47	0.09	28.49	28.58	0.09
420033007	Pennsylvania	Allegheny	24.78	24.87	0.09	28.63	28.77	0.14
010730023	Alabama	Jefferson	31.10	31.12	0.02	31.57	31.59	0.02
550790026	Wisconsin	Milwaukee	30.08	30.10	0.02	33.10	33.12	0.02
180970043	Indiana	Marion	27.13	27.27	0.14	27.76	27.86	0.10
261470005	Michigan	St Clair	32.67	32.73	0.06	33.29	33.33	0.04
550790043	Wisconsin	Milwaukee	31.80	31.85	0.05	33.92	33.94	0.02
180890026	Indiana	Lake	30.49	30.52	0.03	33.39	33.42	0.03
180970081	Indiana	Marion	27.30	27.41	0.11	27.54	27.67	0.13
180970066	Indiana	Marion	28.10	28.21	0.11	29.11	29.25	0.15
171191007	Illinois	Madison	29.32	29.34	0.03	30.64	30.67	0.03
550790010	Wisconsin	Milwaukee	30.83	30.86	0.03	33.13	33.16	0.02
390170003	Ohio	Butler	26.47	26.60	0.13	27.29	27.39	0.10
170316005	Illinois	Cook	32.02	32.05	0.02	34.45	34.47	0.02
420031008	Pennsylvania	Allegheny	24.47	24.63	0.15	25.38	25.57	0.18
261610008	Michigan	Washtenaw	28.47	28.51	0.04	29.26	29.30	0.04
170312001	Illinois	Cook	29.50	29.53	0.03	32.21	32.25	0.04
170310052	Illinois	Cook	29.69	29.70	0.02	30.20	30.21	0.02
421330008	Pennsylvania	York	30.92	30.95	0.03	33.79	33.83	0.04
261630015	Michigan	Wayne	31.02	31.10	0.08	31.91	31.98	0.07
010732003	Alabama	Jefferson	30.62	30.65	0.03	31.46	31.48	0.03
390618001	Ohio	Hamilton	25.96	26.09	0.14	26.64	26.74	0.11
171190023	Illinois	Madison	28.41	28.44	0.03	29.41	29.44	0.03
420031301	Pennsylvania	Allegheny	24.96	25.10	0.14	25.85	25.96	0.11
391130032	Ohio	Montgomery	23.09	23.15	0.06	24.54	24.62	0.08
420030116	Pennsylvania	Allegheny	26.13	26.26	0.12	26.13	26.26	0.12